4

Biodiversity Journal

www.biodiversityjournal.com

ISSN 2039-0394 (Print Edition)
ISSN 2039-0408 (Online Edition)

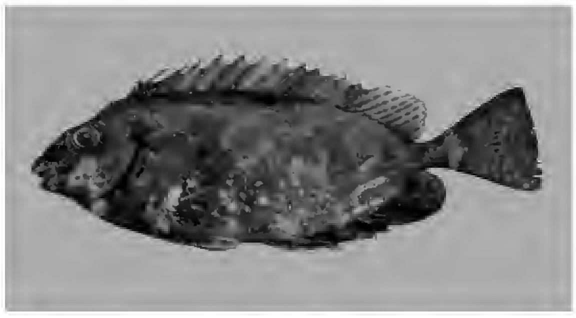
SEPTEMBER 2011, 2 (3): 105-160

with the support of

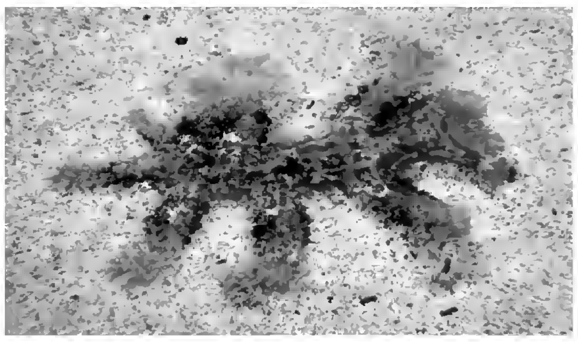
world biodiversity association

FOR NATURALISTIC RESEARCH AND ENVIRONMENTAL STUDIES

Asparagopsis armata Harvey, 1855 - Sliema (Malta)



1



2

3

Cover. *Asparagopsis armata*, Malta, Sliema, 7 m depth, 30.VIII.2011. 1) *Siganus luridus*, Gozo, Xlendi, 6 m depth, 30/07/2011. 2) *Melibe viridis*, Comino, Stanley, 12 m depth, IX.2011. 3) *Rhopilema nomadica*, Malta, Sikka l-Bajda, 4 m depth, XI.2004.

ALIEN SPECIES IN THE MEDITERRANEAN SEA. Allochthonous or alien species are those organisms introduced outside their natural distribution, present or past, across a direct action (intentional or unintentional) by man. The Mediterranean Sea is particularly susceptible to alien species invasion. In addition to the Strait of Gibraltar which is a well-known access route to the Mediterranean, the opening of the Suez Canal in 1869 has fostered, over the years, the introduction of tropical or subtropical species from the Red Sea, a phenomenon which was named, by the engineer F. M. De Lesseps who designed the canal, lessepsian migration. Other principal vectors of the alien species introduction are the mariculture, shipping and or the increase in average water temperature occurred in recent years. Alien species, often invasive species, have out-competed or replaced native species, and are considered pests or cause nuisance.

The Mediterranean sea is a veritable hotspot for such introductions in view of its geographical position and vessel traffic which traverses it. In recent decades, more than 950 new alien species have been encountered in the coastal environments of the eastern Mediterranean Sea.

The influx of marine allochthonous species within the Mediterranean is inexorable indeed, with some benthic invasive alien species (IAS), including the green alga *Caulerpa racemosa* (Forsskål) J. Agardh, 1873 (Caulerpaceae) and the red alga *Asparagopsis armata* Harvey, 1855 (Bonnemaisoniaceae) now having colonised large swathes of the basin. Even the fish, with a number of pelagic species, most notably *Fistularia commersonii* Rüppell, 1838, bluespotted cornetfish (Fistulariidae), *Sphyraena viridensis* Cuvier, 1829, the yellowmouth barracuda (Sphyraenidae) and *Siganus luridus* Rüppell, 1829, dusky spinefoot (Siganidae), are regularly caught by fishermen through most of the Mediterranean. Other invasive species are the nudibranch *Melibe viridis* (Kelaart, 1858) (Tethydidae), the marine gastropod mollusk *Bursatella leachii* (Blainville, 1817), the ragged sea hare or shaggy sea hare (Aplysiidae), the crab *Percnon gibbesi* (H. Milne Edwards, 1853) (Plagusiidae), and the scyphozoan jellyfish *Rhopilema nomadica* Galil, 1990 (Rhizostomatidae), a real trouble for fishermen, bathers and power station operators in the eastern part of the Mediterranean sea.

Alan Deidun, Senior Lecturer Physical Oceanography Unit, Room 315, Chemistry Building 3rd Floor, University of Malta, Msida, MSD 2080, Malta - alan.deidun@gmail.com.

Biodiversity Journal, 2011, 2 (3): 107-114

Some aspects on the reproductive cycle of European conger eel, *Conger conger* (Linnaeus, 1758) (Osteichthyes, Anguilliformes, Congridae) captured from Western Algerian coasts: a histological description of spermatogenesis.

Abi-ayad Sidi-Mohammed El-Amine*[1], Bensahla Talet Ahmed[2], Ali Mehidi Smaïl[3], Dalouche Fatiha[4], & Meliani Fethia Meriem[5]

Laboratoire Aquaculture & Bioremédiation (AQUABIOR). Department of Biotechnology, Department of Biotechnology Faculty of Sciences (I.G.M.O.), Oran University, Oran; Algeria. [1]a.abi-ayad@hotmail.com, [2]ahmedbensahla@yahoo.fr, [3]alimehidis@gmail.com, [4]fdalouche@yahoo.fr, [5]mimi3s5@hotmail.com - *corresponding author

ABSTRACT The aim of this work was to study the annual reproductive cycle of European conger eel (*Conger conger,* Linnaeus, 1758) through analysis and description of spermatogenesis. A sample of 168 males was captured between September 2008 and August 2009 from the Western coast of Algeria, from Béni Saf. Fish length and weight varied between 26.20-112 cm and 0.45-3.44 kg, respectively.

Condition factors (K), gonadosomatic index (G.S.I.) and hepatosomatic index (H.S.I.) were calculated monthly. Factor K reached the minimum in August/September (0.10%) corresponding to reproductive period and a maximum in January (0.18%). Although G.S.I. values revealed to be statistically not significant, there were two peaks for G.S.I., the first in March, denoting the beginning of spermatogenesis, and the second in August/September, indicating the reproduction period. H.S.I. reached a peak in December (1.90%), then the value decreased to a minimum in April.

Histological analysis of testis allowed us to distinguish 5 stages summarized as follows: Stage 1: Spermatogonia A; Stage 2: Spermatogonia B; Stage 3: Spermatocytes and spermatids; Stage 4: Spermatocytes, spermatids and spermatozoa (cytodifferentiation of spermatids into spermatozoa); Stage 5: Spermatozoa (spermiogenesis or cytodifferentiation of spermatids into spermatozoa).

KEY WORDS Condition factor, *Conger conger*, G.S.I., H.S.I., reproduction, spermatogenesis.

Received 16.05.2011; accepted 05.07.2011; printed 30.09.2011

INTRODUCTION

The European conger eel (*Conger conger*) is distributed in the Eastern North Atlantic Ocean from Norway to Senegal (including the Canary Islands, Azores and Madeira), in Mediterranean and western Black Sea (F.A.O., 2011). Specimens spawn, probably once in lifetime in summer (Cau & Manconi, 1984), in the Mediterranean and in the eastern North Atlantic around Azores (McCleave & Miller, 1994; Vallisneri et al., 2007). In Mediterranean Sea, males are usually smaller than females, with males rarely exceeding 100 cm in length and females reaching over 200 cm (Cau & Manconi, 1984). Since a decade, European conger eels (*C. conger*) constitute an important and valuable fishery resource (Figueiredo et al., 1996; Morato et al., 1999; O'Sullivan et al., 2003) in Mediterranean countries (Relini et al., 1999) and, particularly, in Algeria. However and to our knowledge, no studies on eco-biology of this important benthic species (Vallisneri et al., 2007) from South shore of Mediterranean Sea have been published. Moreover, there is evidence of declining stocks of the species (Menezes & Silva, 1999; O'Sullivan

et al., 2003) and there has been no detailed published study on its reproductive biology and especially on the dynamics of spermatogenesis. According to F.A.O. (2011), total world catch of *C. conger* was estimated in 2009 to 17,229 tons. It is clear that conger species are subject to overfishing (Menezes & Silva, 1999; Mochioka & Tokai, 2001), which caused a drastic fall in its capture. Moreover, *C. conger* is very sensitive to exploitation and constitutes an important species in fish biodiversity and in biodiversity's balance (Correia et al., 2006).

The objective of the present study was to elucidate the process of male maturation of European conger eel (*C. conger*) by examination of annual changes in condition factor K, gonadosomatic and hepatosomatic indexes (G.S.I. and H.S.I., respectively) and gonadal histology. This latter constitutes the first detailed information on the species in Mediterranean.

MATERIAL AND METHODS

Fish samples: *Conger conger* employed for this study were captured from the Western coast of Algeria, from Béni-Saf, at a depth ranging between 100 and 150 meters. Total of 168 males were sampled, 60 in autumn, 33 in winter, 35 in spring and 40 in summer. Fresh specimens, collected by fishermen, were examined in laboratory. Total length (cm) and weight (g) and liver and gonad weight were measured for all individuals. Total length varied between 26.20 and 112 cm and total weight varied between 0.45 and 3.44 kg. Note that in May and June 2009, samples contained only female specimens.

Indices of fish condition: In this study, we calculated, monthly, values of:

- Condition factor K [K = (total weight / total length ^{3}) x 100],
- Gonadosomatic index [G.S.I. = (gonad weight / total weight) x 100],
- Hepatosomatic index [H.S.I. = (liver weight / total weight) x 100].

Histological study: A 1 cm fragment from the gonad of each fish was removed and fixed in Bouin's solution, then dehydrated and embedded in paraplast. For histological examination, the tissues were cut into sections of 5 microns and stained with a trichrome method according to Langeron (1942): Regaud's haematoxyline at 57 °C, phloxine and green light. Histological descriptions of gonadal developmental stages were based on the criteria reported by Yamamoto et al. (1972) and Grier (1981).

Statistical Analysis: All data were expressed as mean ± standard deviation and were statistically compared by one-way variance analysis or ANOVA 1 (for condition factor K and Gonadosomatic index or G.S.I.) and by non parametric variance analysis of Kruskal-Wallis and Mann-Withney *U*-test (for hepatosomatic index or H.S.I.) (d'Hainaut, 1975a, b).

RESULTS

Indices of fish condition

Condition factor K: Condition factor K (Fig. 1) remained stable between September and December 2008, then increased significantly ($p<0.05$) and reached a maximum (0.18% ± 0.03%) in January 2009. Between February and August 2009, K factor decreased significantly ($p<0.05$).

Gonadosomatic (G.S.I.) and hepatosomatic (H.S.I.) indexes: Statistical comparison by ANOVA 1 of G.S.I. showed no significant differences among data obtained. As a description of G.S.I. results, in terms of absolute value, G.S.I. decreased not significantly ($p\geq0.05$) steadily and continuously between October 2008 and February 2009. In March 2009, G.S.I. reached a high value (2.92% ± 3.36%), then decreased not significantly ($p\geq0.05$) between April and July. Note that in May and June, only female specimens were caught. In September 2008 and August 2009, G.S.I. increased not significantly ($p\geq0.05$) again and reached a high value 3.97% ± 4.10% and 3.37% ± 5.23%, respectively (Fig. 2). Because of important differences between the raw values, standard deviation was high and in some cases higher than mean. Indeed, in September 2008, March and August 2009 G.S.I. raw values varied between 0.34%-12.29%, 0.24%-10.02% and 0.15%-14.16%, respectively. This can explain the results

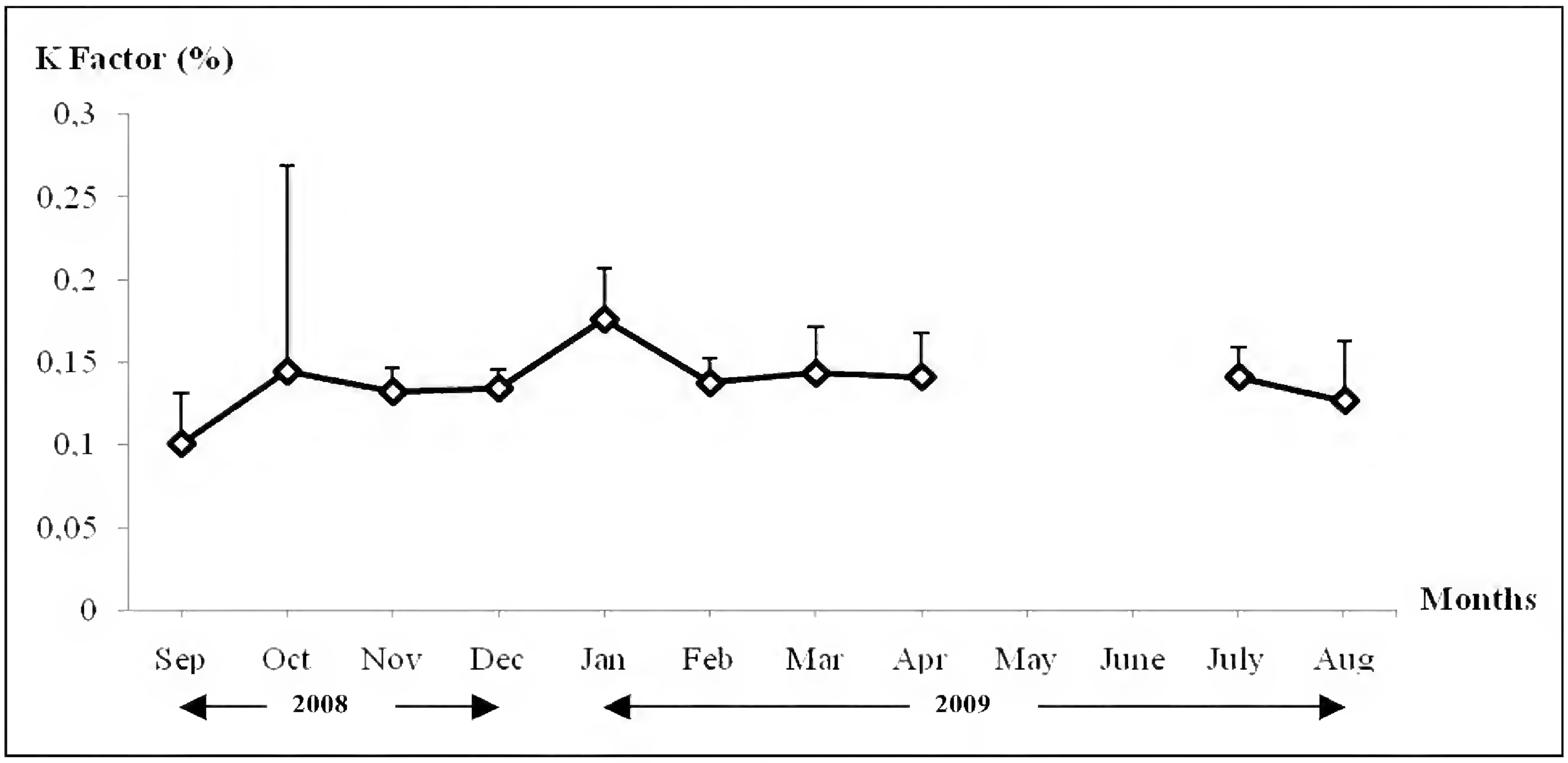


Figure 1: Time evolution of the condition factor K (mean ± standard deviation expressed in %) in male European conger eel *(Conger conger)*.

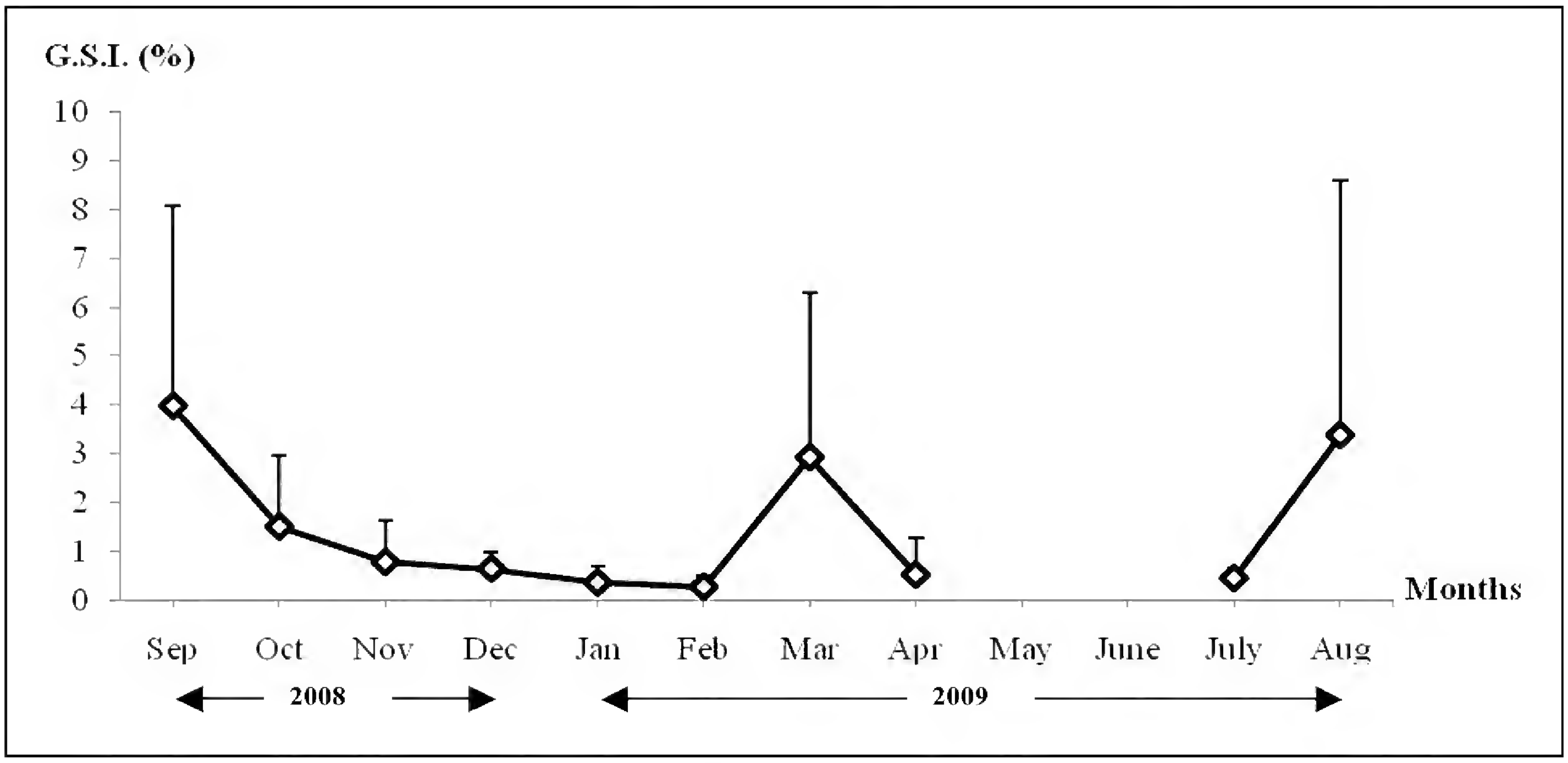


Figure 2: Time evolution of G.S.I. (mean ± standard deviation expressed in %) in male European conger eel *(Conger conger)*.

obtained which, however, were not significant at all from a statistical point of view.

The value of H.S.I. increased to a maximum in December 2008 ($p<0.05$), then decreased significantly and continuously ($p<0.05$) until February 2009. Between February and August 2009 (Fig. 3), H.S.I. value remained stable and the data revealed no significant variations ($p\geq0.05$). Similarly, data on H.S.I. were not available in May and June 2009 because of lack of male specimens during this period.

Histological parameters

Histological stages of sperm cells varied significantly according to period of sampling.

Stage 1: This stage was observed between November and December 2008 and was characterized by the presence of spermatogonia A (Fig. 4). The nucleus presented a clear appearance after staining and cytoplasm presented a patch of dense granular and fibrillar material called “cloud”, usually near the nuclear membrane.

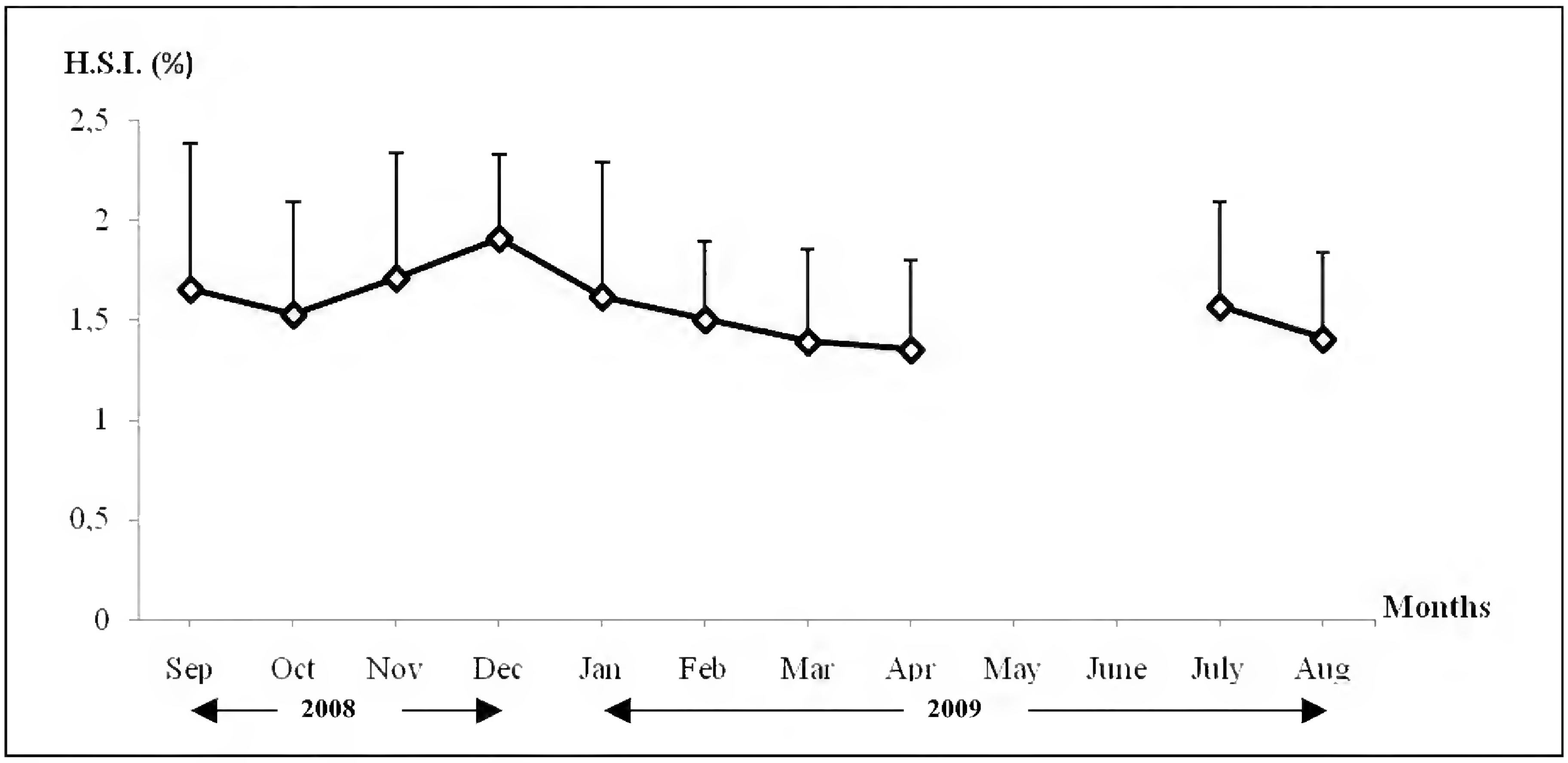


Figure 3: Time evolution of H.S.I. (mean ± standard deviation expressed in %) in male European conger eel *(Conger conger)*.

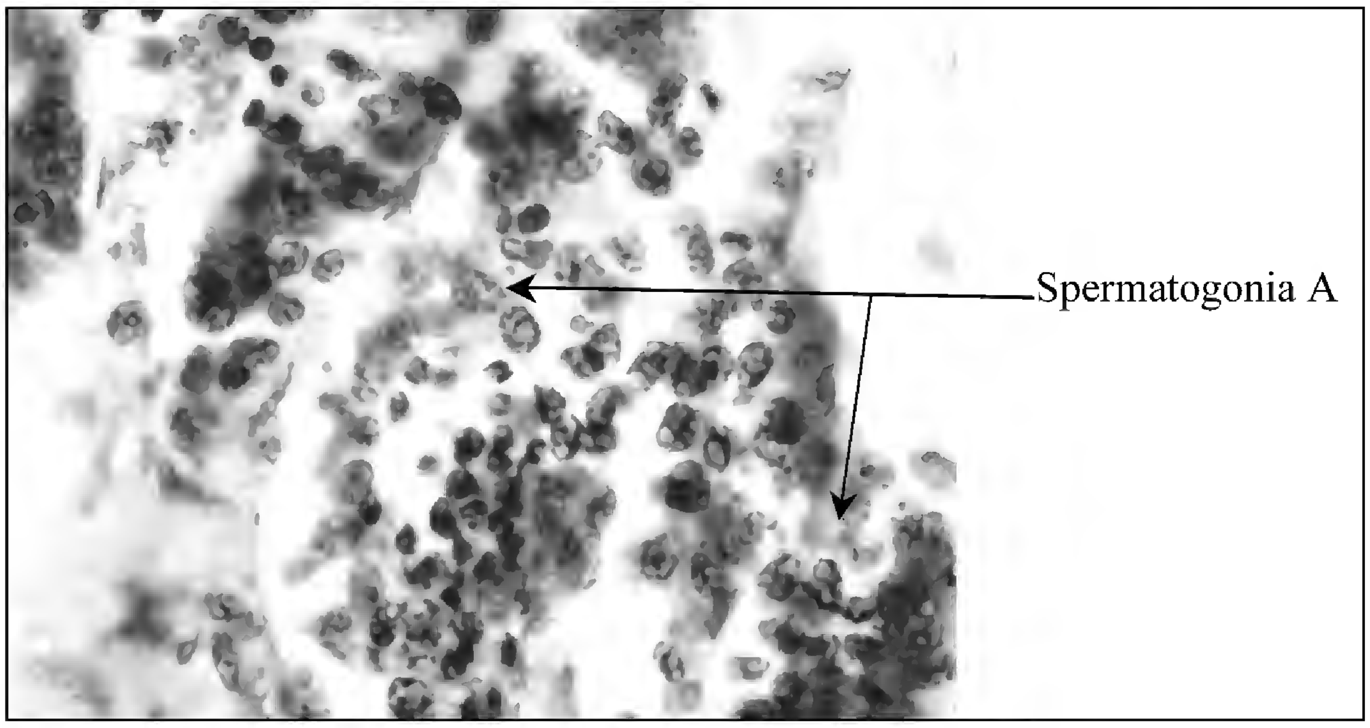


Figure 4: Histological section representative of spermatogonia A (800x) during early spermatogenesis (November-December) in European conger eel *(C. conger)*. G.S.I. = 0.93%.

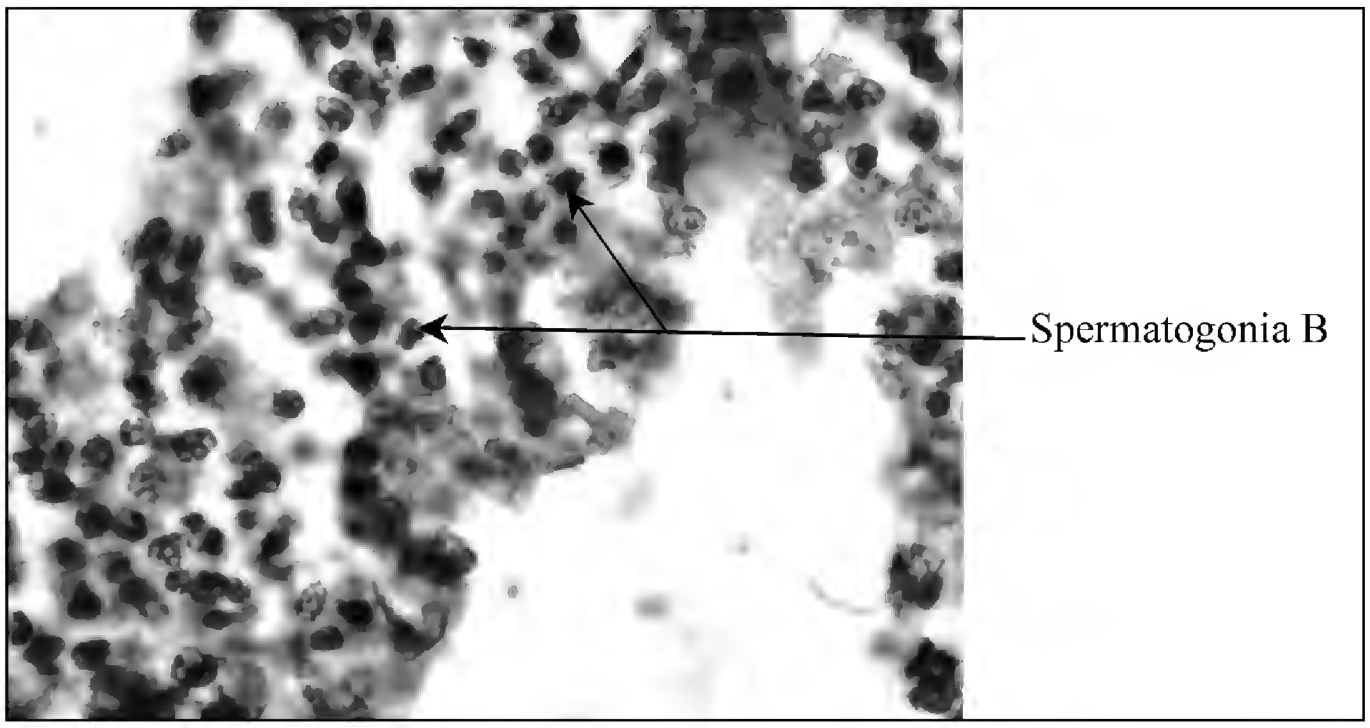


Figure 5: Histological section representative of spermatogonia B (800x) during spermatogenesis initiation (December-February) in European conger eel *C. conger)*. G.S.I. = 1.05%.

Stage 2: This stage was observed from December until February and indicated the beginning of spermatogenesis, with the occurrence of spermatogonia B. These cells were smaller and more intensely colored than spermatogonia A (Fig. 5).

Stage 3: This stage was observed in March 2009 and was characterized by the occurence of spermatocytes (Fig. 6) at various stages (spermatocytes I and II). Spermatocytes have a great round or oval nucleus. During this stage, we observed the meiotic phase characterized by the occurrence of spermatids.

Stage 4: This stage was observed between July and October 2009 and indicated the occurrence of spermiogenesis. Because of lack of male specimens in samples of May and June 2009 we were unable to determine at what month this stage exactly begins. The testes contained spermatocytes, spermatids and the maturing cells representative of the differentiation of spermatids into spermatozoa (Fig. 7). These curved-shaped cells (average length: 3.84 µm) were strongly stained with haematoxyline.

Stage 5: This stage was observed in September 2008 and only in one specimen. The testis showed only the maturing cells representative of the differentiation of spermatids into spermatozoa (Fig. 8).

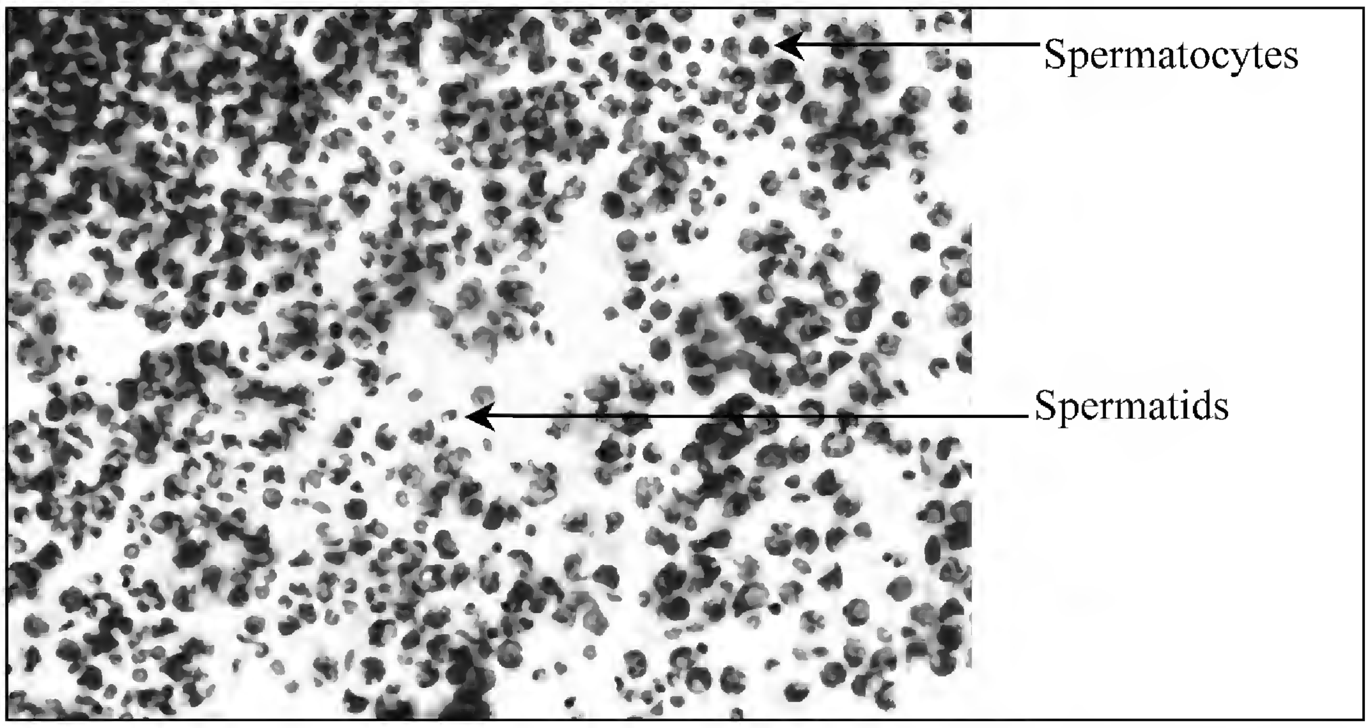


Figure 6: Histological section representative of spermatocytes and spermatids (800x) at the end of spermatogenesis (March-April) in European conger eel *(C. conger)*. G.S.I. = 5.84%.

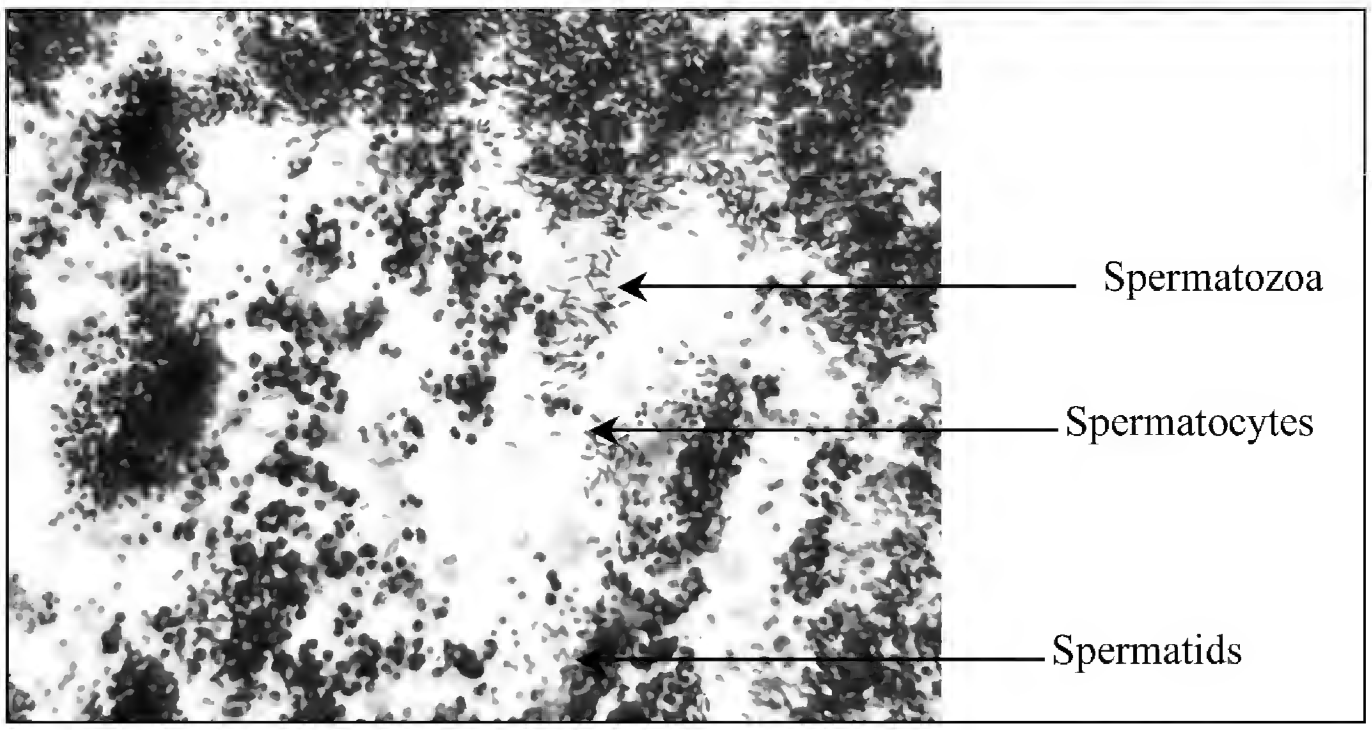


Figure 7: Histological section representative of spermatocytes, spermatids and spermatozoa in differentiation (800x) during spermiogenesis (August) in European conger eel *(C. conger)*. G.S.I. = 13.30%.

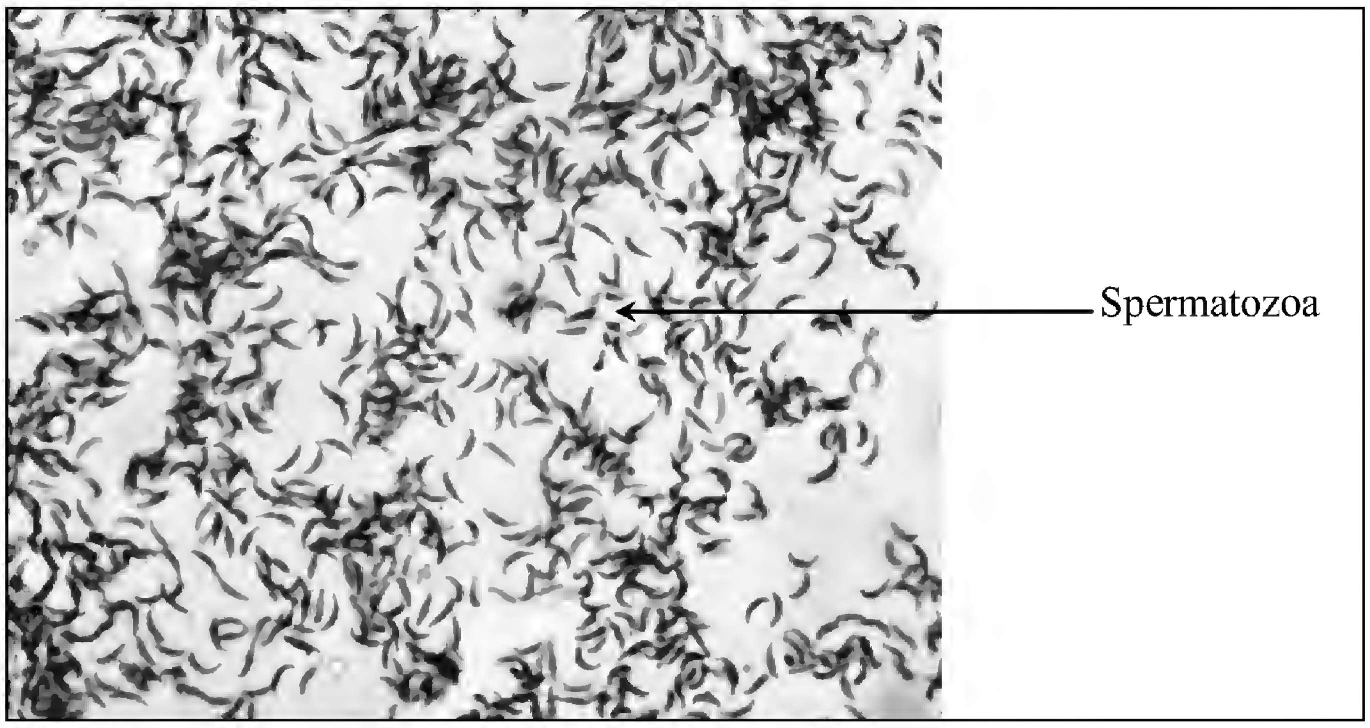


Figure 8: Histological section showing spermatozoa in differentiation (800x) during spermiogenesis (September) in European conger eel *(C. conger)*. G.S.I. = 4.60%.

DISCUSSION

Little data exist on reproductive biology of conger species and especially *C. conger* (Relini et al., 1999; Sbaihi et al., 2001), so comparisons are difficult to make. The condition factor K of *Conger conger* was highest in winter, in January 2009, and lowest in summer, during September 2008 and August 2009. The decrease in the value of this factor in summer probably resulted in a weight loss for the fish, indicating that fishes used most of somatic energy reserves during migration and reproductive development. In Irish coastal waters, O'Sullivan et al. (2003) showed, in female *C. conger*, the highest and the lowest values of condition factor, in autumn and winter, respectively. The difference resulted probably from the coldest temperature observed in Oceanic waters (Irish waters) compared to south Mediterranean waters (present study).

In this study, gonadosomatic index (G.S.I.) presented two peaks, the first in summer and the second in spring. Although these data were not statistically significant, nevertheless, the first peak could be explained by prespawning and spawning period. Indeed, many studies showed that European conger eel spawn in summer (Relini et al., 1999; Vallisneri et al., 2007; Abi-ayad et *al.*, personal unpublished data). In addition, Utoh et al. (2004) showed that captive Japanese conger eels (*C. myriaster*) had a spermiation period from May to September with G.S.I. peak mean value of 5.3% ± 3.0% and a highest G.S.I. value of 9.3% measured in a specimen in June. In this study, the highest mean value of G.S.I. was measured in September 2008 (3.97% ± 4.10%) and August 2009 (3.37% ± 5.23%) and the highest and lowest G.S.I. raw values, 14.16% and 0.15%, were measured in August 2009. These latter results can explain that in many cases standard deviation values were higher than means values. After breeding, we measured a decrease in testicular weight justifying the reduction in value of the G.S.I. (Abi-ayad et al., 2004; Utoh et al., 2004). However, in coldest waters, Hood et al., (1988) and O'Sullivan et al., (2003) showed lowest and highest G.S.I. during autumn and late winter/spring in *C. oceanicus* and *C. conger*, respectively. In this study, a second high G.S.I. was obtained in spring (March 2009). This was probably due to the presence of males in advanced stages of spermatogenesis. The decline of G.S.I. in April and July 2009 may be due to the migration of males, by that time ready for breeding, to spawning area at great depths.

The H.S.I. was highest in early winter (December 2008). This coincided with hepatic fats deposits due to intense feeding activity during summer period and, probably, useful for fish gonad maturation. In April 2009, H.S.I. was at its lowest level. This could indicate that the reserves stored in the liver during summer/autumn were invested in the development of sexual products, but also used as energy source when fish reduce their feeding during migration to the breeding area. This is confirmed by microscopic examination of gonads which showed that

spermatogenesis of European conger eel started in March. Histological study of testis confirmed lobular structure in the European conger eel, also observed in the European eel (*Anguilla anguilla*) and in many teleosts species (Todd, 1980). In this study, we classified the process of spermatogenesis into five stages. The testicular structure showed that spermatogonia A (stage 1) occurred in November and December 2008 and spermatogonia B (stage 2) from December 2008 to February 2009, when G.S.I. was lowest and K factor was highest. This may be related to trophic phase which is completed before maturation (Cau & Manconi, 1984; Utoh et al., 2004). Meiotic divisions of spermatocytes started in March (stage 3) and corresponded to the first peak of G.S.I. In wild winter flounder (*Pleuronectes americanus*) G.S.I. was high before appearance of spermatozoa (Harmin et al., 1995). In the present study we do not know when this stage ends, because of lack of male specimens in samples of May and June 2009. Histological examinations performed between August and October, when G.S.I. was at its second highest level, showed spermatocytes, spermatids and spermatozoa in final maturation (stages 4 and 5). This corresponded to the phase of late spermatogenesis and spermiogenesis. Indeed, Utoh et al., (2004) showed that G.S.I. remained at high levels in the late phase of spermatogenesis, during spermiation in reared Japanese conger (*C. myriaster*).

In conclusion, the rational management of fish biodiversity and fishery necessitates understanding on eco-biology of target species. This study showed a (although statistically weak) relation between biometrics parameters and spermatogenesis's dynamics in European conger eel. Furthermore, these results provide the first information on reproductive biology of *C. conger* captured in Western Algerian coasts (North African area) and report observations on cytodifferentiation of spermatids into spermatozoa (spermiogenesis) in male wild European conger eel (*C. conger*).

ACKNOWLEDGEMENTS

The authors thank the Algerian Ministry of Higher Education and Scientific Research (MESRS) which funded this experimental study within the framework of CNEPRU project No F01820090018.

REFERENCES

Abi-ayad S.-M. E.-A., Kestemont P. & Mélard C., 2004. Variations saisonnières des lipides et des acides gras chez les géniteurs de perche (*Perca fluviatilis*) maintenus en captivité. Sciences et Technologies, 21: 53-59.

Cau A. & Manconi P., 1984. Relationship of feeding, reproductive cycle and bathymetric distrubution in *Conger conger.* Marine Biology, 81: 147-151.

Correia A., Faria T. R., Alexandrino P., Antunes C., Isidro E. J. & Coimbra J., 2006. Evidence for genetic differentiation in the European conger eel (*Conger conger*) based on mitochondrial DNA analysis. Fisheries Science, 72: 20-27.

d'Hainaut L., 1975a. Concepts et méthodes de la statistiques. Tome 1. Education 2000, Edition Labor (Bruxelles) et Fernand Nathan (Paris). 369 pp.

d'Hainaut L., 1975b. Concepts et méthodes de la statistiques. Tome 2. Education 2000, Edition Labor (Bruxelles) et Fernand Nathan (Paris). 384 pp.

F.A.O., 2011. Fisheries and Aquaculture Department. FIGIS: Species Fact Sheets. Species Identification and Data Programme. Chapter: *Conger conger*. www. fao.org/fishery/species/2994/en.

Figueiredo M.J., Figueiredo I. & Correia J., 1996. Caracterizacao geral dos recursos de profundidade em estudo no IPIMAR. Relatórios Técnicos e Científicos. Instituto Português de Investigação Marítima, 21: 50 pp.

Grier H. J., 1981. Cellular organization of the testis and spermatogenesis in fishes. American Zoologist, 21: 345-357.

Harmin S.A., Crim L.W. & Wiegand M.D., 1995. Plasma sex steroid profiles and the seasonal reproductive cycle in male and female winter flounder, *Pleuronectes americanus*. Marine Biology, 121: 601-610.

Hood P.B., Able K.W. & Grimes C.B., 1988. Biology of the conger eel *Conger oceanicus* in the Mid-Atlantic Bight. Marine Biology, 98: 587-596.

Langeron M., 1942. Précis de microscopie: Technique-Expérimentation-Diagnostique. Edition Masson et Cie (Paris). 1339 pp.

McCleave J.D. & Miller M.J., 1994. Spawning of *Conger oceanicus* and *Conger triporiceps* (Congridae) in the Sargasso Sea and subsequent distribution of leptocephali. Environmental Biology of Fishes, 39: 339-355.

Menezes G. &. Silva H.M., 1999. Cruzeiros dirigidos às espécies demersais nos Açores. Relatório da 16ª Semana das Pescas dos Açores. 1997: 195-218.

Mochioka N. & Tokai T., 2001. Fisheries biology and fisheries of white-spotted conger-eel *Conger myriaster*. Kaiyo Monthly, 33, 525- 528.

Morato T., Solà E., Gros M.P. & Menezes G., 1999. Diets of Korkbeard (*Phycis phycis*) and conger eel (*Conger conger*) of the azores during spring of 1996 and 1997. Arquipelago. Life and Marine Science, 17: 51-64.

O'Sullivan S., Moriarty C., Fitzgerald R.D., Davenport J. & Micahy M.F., 2003. Age, growth and reproductive

status of the European conger eel, *Conger conger* in the Irish coastal water. Fisheries Research, 64: 55-69.

Relini, G., Bertrand J & Zamboni A., 1999. Sintesi delle conoscenze sulle risorse da pesca dei fondi del Mediterraneo Centrale (Italia e Corsica). Biologia Marina Mediterranea, 6: 174-179.

Sbaihi M., Fouchereau-Peron M., Meunier F., Elie P., Mayer I., Burzawa-Gerard E., Vidal B. & Dufour S., 2001. Reproductive biology of the conger eel from the south coast of Brittany, France and comparison with the Europe eel. Journal of Fish Biology, 59, 302-318.

Todd, P. R., 1980. Size and age of migrating New Zealand freshwater eels (*Anquilla* spp.). New Zealand Journal of Marine and Freshwater Research, 14; 283–293.

Utoh T., Okamura A., Yamada Y., Tanaka S., Mikawa N., Akazawa A., Horie N., H.P. Oka H. P., 2004. Reproductive cycle in reared male common Japanese conger, *Conger myriaster.* Aquaculture, 240: 589–605.

Vallisneri M., Scapolatempo M. & Piccinetti C., 2007. Preliminary biological data on the northeast Mediterranean conger eel (*Conger conger*). Boletin Instituto Espanol De Oceanografia, 23: 111-114.

Yamamoto K., Hiroi O., Hirano T. & Morioka T., 1972. Artificial maturation of cultivated male Japanese eels by synahorin injection. Nippon Suisan Gakkaishi, 38: 1083-1090.

Biodiversity Journal, 2011, 2 (3): 115-120

Exploring the vegetation dynamics and community assemblage in Ayubia National Park, Rawalpindi, Pakistan, using CCA

Sheikh Saeed Ahmad* & Qurat Ul Ann

Department of Environmental Sciences, Fatima Jinnah Women University, Rawalpindi, Pakistan.
* corresponding author: drsaeed@fjwu.edu.pk, 00 92 321 5167726.

ABSTRACT The relationship between species diversity and overall community assemblage was identified in two different zones in Ayubia National Park (Rawalpindi, NE-Pakistan) which is recognized as protected area. Canonical Correspondence Analysis (CCA) was used to find correlation of environmental variables with species abundance/richness. Results showed that in Zone 1 species were rather scattered due to the less availability of organic matter and soil moisture as they occupy the less dense forest cover. Whereas Zone 2 showed the opposite trends. Finally the overall zones showed that maximum number of quadrats included Zone 2 species due to a great forest cover with excess amount of organic matter and soil moisture. The study highlighted the importance of dynamic nature and composition of vegetation and stressed the need of conservation of native flora for future generations.

KEY WORDS Canonical Correspondence Analysis, Species richness, Soil moisture, Ayubia National Park, Pakistan.

Received 27.05.2011; accepted 10.08.2011; printed 30.09.2011

INTRODUCTION

A National park is an area set aside by a national government for the preservation of the natural environment. The World Conservation Union defines a National park as a natural area designated to protect the ecological integrity of one or more ecosystems for present and future generations. In Pakistan, the earlier ecological studies were generally observational. The earlier studies, generally appeared in 1950's, were confined to visual description of the vegetation, and no attempts were made to recognize community types and to correlate them with the relevant environmental factors. On the contrary, advanced multivariate techniques of ordination and cluster analysis had been routinely used in Europe and other parts of the world. There are numerous ordination methods accessible in plant bionetwork, some of which have been extensively used, e.g. Principal Component Analysis (PCA) and Detrended Correspondence Analysis (DCA) (Hill & Gauch, 1980), whereas some others only sporadically used (Zhang, 2004). A series of studies using different ordination techniques were carried out in Pakistan by Ahmad et al., 2009; Ahmad, 2009; Jabeen & Ahmad, 2009; Pirzada et al., 2009; Ahmad et al., 2010a, b; Ahmad, 2011. In Canonical Correspondence Analysis (CCA) the floristic statistics and the environmental variables can be assimilated within the ordination (Kashian et al., 2003). Within the Ayubia National Park, the study area was the moist temperate forest in Rawalpindi, NE-Pakistan (Fig. 1), showing a high diversity of susceptible plant and animal species. The geographical location of the park is 330° 52' N and 730° 90' E (Farooque, 2002).

The aim of this research was to quantify the vegetation in Ayubia National Park using ordination techniques and to determine the soil-vegetation relationship to provide basic awareness for preservation of nationally significant native flora.

A list of plant species present in the study area is provided in Table 1. Apart from their importance from ecological point of view few species are used as medicinal herbs by local inhabitants. Observed biodiversity of occuring species indicate that this area can be used for conservation of native flora.

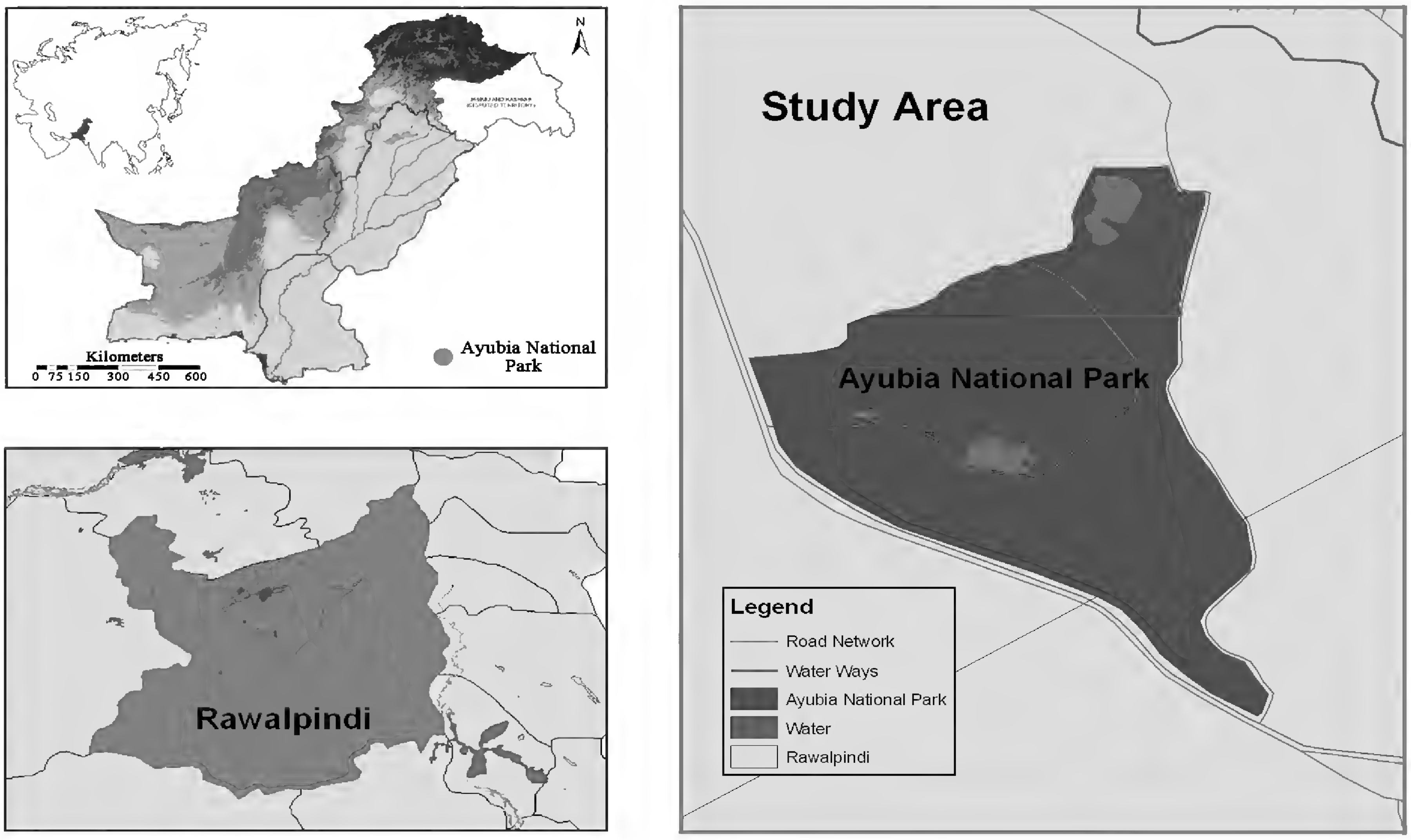


Figure 1. The geographical location of the Ayubia National Park, Rawalpindi, NE-Pakistan.

MATERIALS AND METHODS

For the clear communities demarcation study area was divided into two zones. Zone 1 was located about 1 m from the walking track. 60 quadrats were laid down along both sides (30 quadrats on each side). Quadrat method was used for the collection of vegetation data. Quadrat size of 1×1 m was selected because a high number of herbs and shrubs were present in the area. Within each quadrat, cover values of plants were recorded by visual estimation according to Domin Cover Scale (Kent & Coker, 1995). Nomenclature was as in Nasir & Rafiq (1995). Soil variables include pH, organic matter (Nikolskii, 1963) and soil moisture (Allen, 1974). Principal Component Analysis (PCA) and Canonical Correspondence Analysis (CCA) ordination methods were applied for data quantification and analysis.

RESULTS

The most important way of exploring the multivariate data sets is based on the ordination results. In fact, the first ordination axis is frequently correlated with one environmental variable, thus helping in identifying the abundance and occurrence of individual species related to environmental factors. Different or multiple approaches can depict such a relation including the response curve of species along the moisture gradient. In Zone 1 classification of species was based upon soil moisture content within 30 Quadrats. Biplot of species and environmental variables against soil moisture divided it into four classes i.e. Class Moisture 1 included 13 Quadrats, Class Moisture 2 included 4 Quadrats, Class Moisture 3 included 10 Quadrats and Class Moisture 4 included 3 Quadrats.The results showed that Zone 1 species mostly fall into class moisture 1 due to availability of thick forest cover and high contents of organic matter. The distance between the symbols in the diagram approximates the different distribution of relative abundance of the species across the area.

Points resulting very close to each other correspond to species often occurring together. Segmentation of these symbols into slices was based on currently active classification of samples. Relative size of particular pie-slice corresponds to relative importance (measured either by number of presences or sum of

Species name	Families
Vinca major Linnaeus (1789)	Apocynaceae
Hedera nepalensis K.Koch (1753)	Araliaceae
Polygonatum verticillatum All. (1754)	Aspargaceae
Cichorium intybus Linnaeus (1753)	Asteraceae
Taraxacum officinale Wigg. (1881)	Asteraceae
Asparagus gracilis Royle (1753)	Asteraceae
Thlaspi griffithianum (Boiss.) Boiss (1753)	Brassicaceae
Cardamine impatiens Linnaeus (1753)	Brassicaceae
Sisymbrium decomposita Linnaeus (1753)	Brassicaceae
Cannabis sativa (Linnaeus) (1753)	Canabinaceae
Viburnum foetens Decaisne (1753)	Caprifoliaceae
Cerastrium fontanum Baumg. (1753)	Caryophullaceae
Dipsacus strictus D. Don (1754)	Dipasaceae
Euphorbia wallichii Hook.f. (1753)	Euphorbiaceae
Indigofera heterantha Wall ex. Brand. (1753)	Fabaceae
Erodium cicutarium (Linnaeus) L, Herit ex Ait. (1789)	Geraniaceae
Mentha longifolia (Linnaeus) All. (1753)	Lamiaceae
Calamintha vulgaris Linnaeus (1754)	Lamiaceae
Nepeta connata Linnaeus (1753)	Lamiaceae
Lonicera quinquelocularis Hardw. (1753)	Linaceae
Oxalis corniculata Linnaeus (1753)	Oxalidaceae
Plantago major Linnaeus (1753)	Plantaginaceae
Poa pratensis Linnaeus (1753)	Poaceae
Cynodon dactylon (Linnaeus) Pers. (1753)	Poaceae
Polyphyllum hexandrum I. (1753)	Podophyllaceae
Rumex nepalensis Spreng. (1753)	Polygonaceae
Adiantum caudatum Forsk (1753)	Pteridaceae
Dryopteris ramose (Hope) C.Chr. (1753)	Pteridaceae
Adiantum capillus-veneris Linnaeus (1753)	Pteridaceae
Clematis grata Wall. (1754)	Ranunculaceae
Aquilegia pubiflora Wall ex Royle (1754)	Ranunculaceae
Fragaria vesca Lindley ex Lacaita (1753)	Rosaceae
Fragaria nubicola Lindley ex Lacaita (1753)	Rosaceae
Duchesnea indica (Andr.) Focke (1811)	Rosaceae
Potentilla gerardiana Lindley ex Lehm. (1753)	Rosaceae
Galium aparine Linnaeus (1753)	Rubiaceae
Bergenia himalaica Boriss. (1974)	Saxifragaceae
Bergenia ciliate (Haw.) (1831)	Saxifragaceae
Scrophularia decomposita Royle ex Benth (1753)	Scrophulariaceae
Urtica dioica Linnaeus (1753)	Urticaceae
Valeriana jatamansi Jane (1805)	Valerianaceae
Valerianella dentatam (L.) Poll. (1754)	Valerianaceae
Viola canescens Wall.ex Roxb. (1753)	Violaceae

Table 1: List of plant species in Ayubia National Park, Rawalpindi, Pakistan.

abundances) of the current species in the particular class of samples (Fig. 2).

Similarly, figure 3 explains the classification of species of Zone 2 in relation to soil moisture content. Soil moisture was separated into four classes i.e. Class moisture 1 included 8 Quadrats, Class moisture 2 included 7 Quadrats, Class moisture 3 included 9 Quadrats and Class moisture 4 included 6 Quadrats, the maximum number of samples occurring in Class moisture 3. This analysis depicts that Zone 2 species fall in class moisture 3 because of more availability of organic matter and maximum forest cover in that area. Overall species of both zones classification respect to soil moisture was analyzed. It showed that Class moisture 1 included 18 Quadrats, Class moisture 2 included 24 Quadrats, Class moisture 3 included 5 Quadrats and Class moisture 4 included 13 Quadrats. The analysis of these results showed that a high number of Quadrats comprised Zone 2-species due to dense forest canopy resulting in more availability of raw material for the formation of organic matter (Fig. 4).

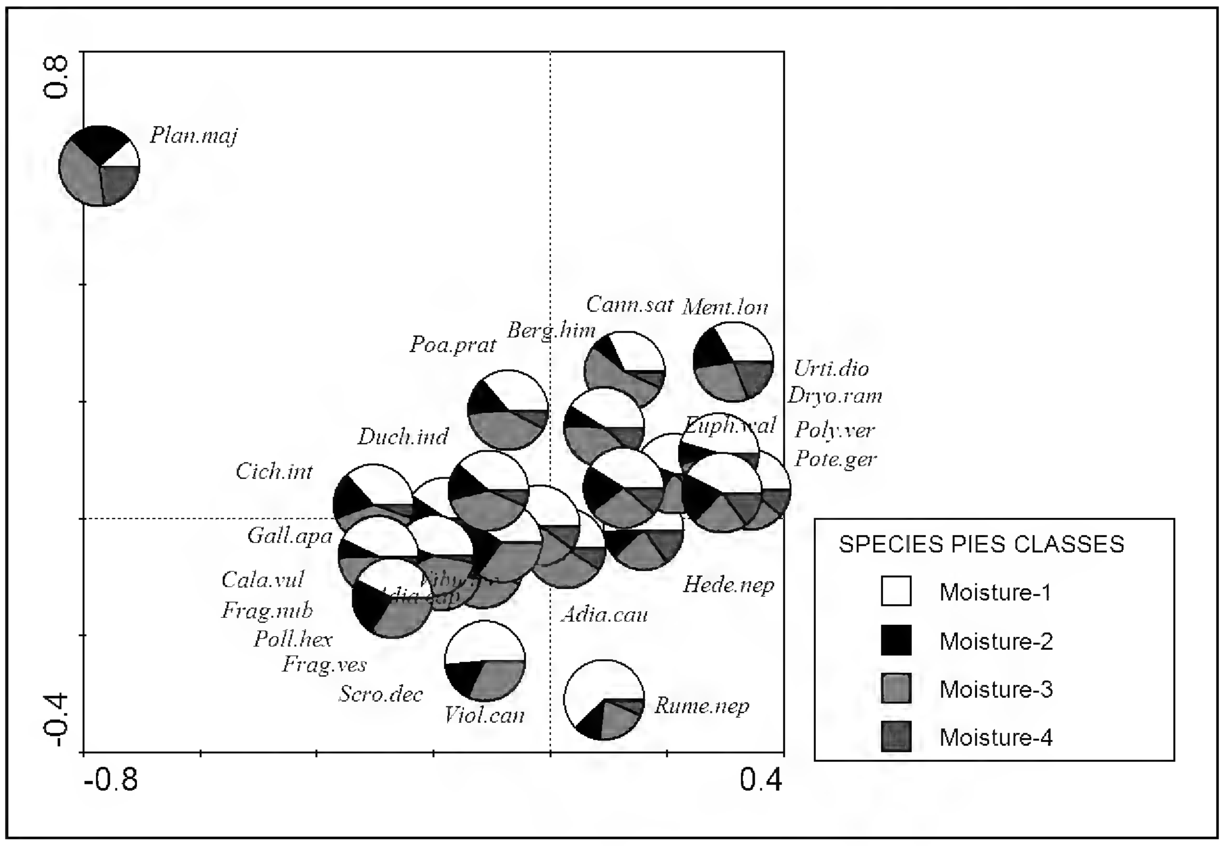


Figure 2: Pie symbols plot of (Zone 1) species over classes of samples with different soil moisture.

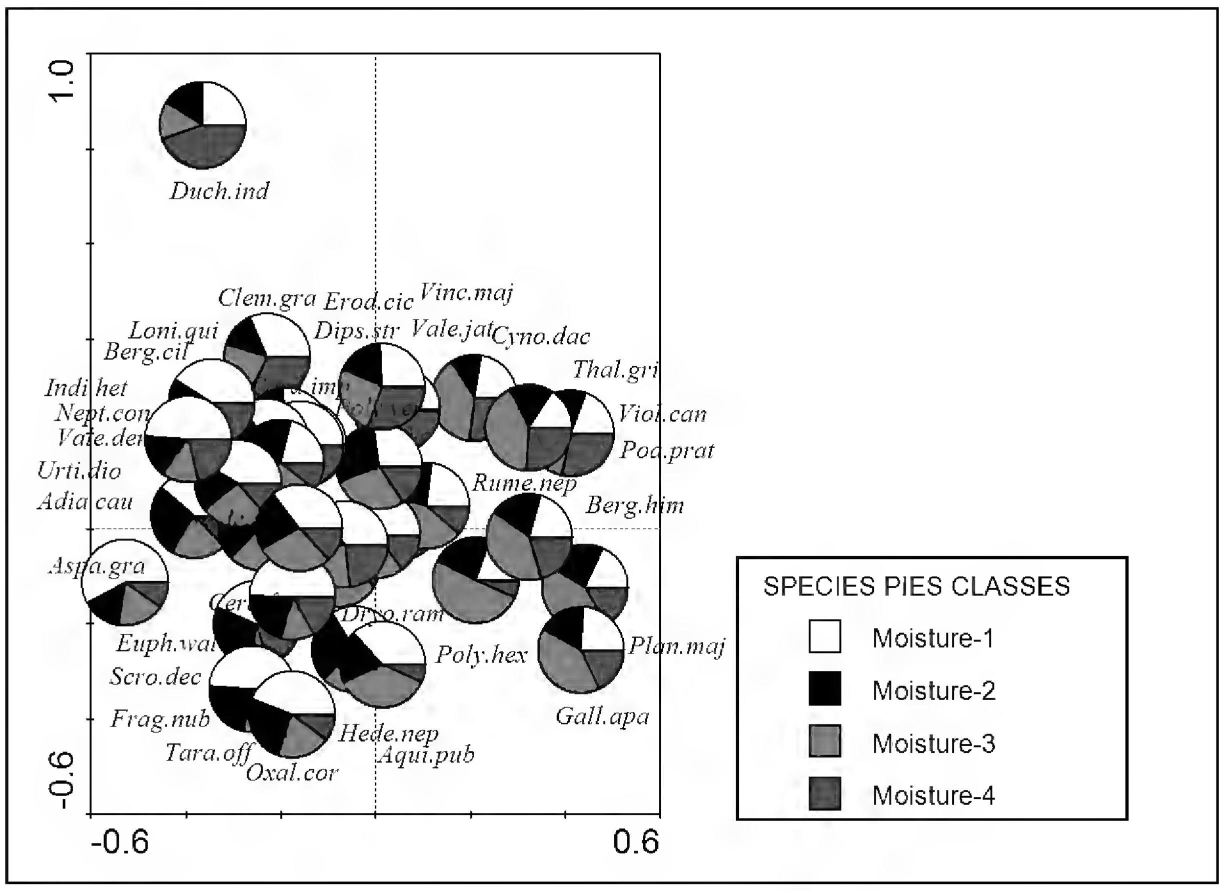


Figure 3: Pie symbols plot (Zone 2) of species over classes of samples with different soil moisture.

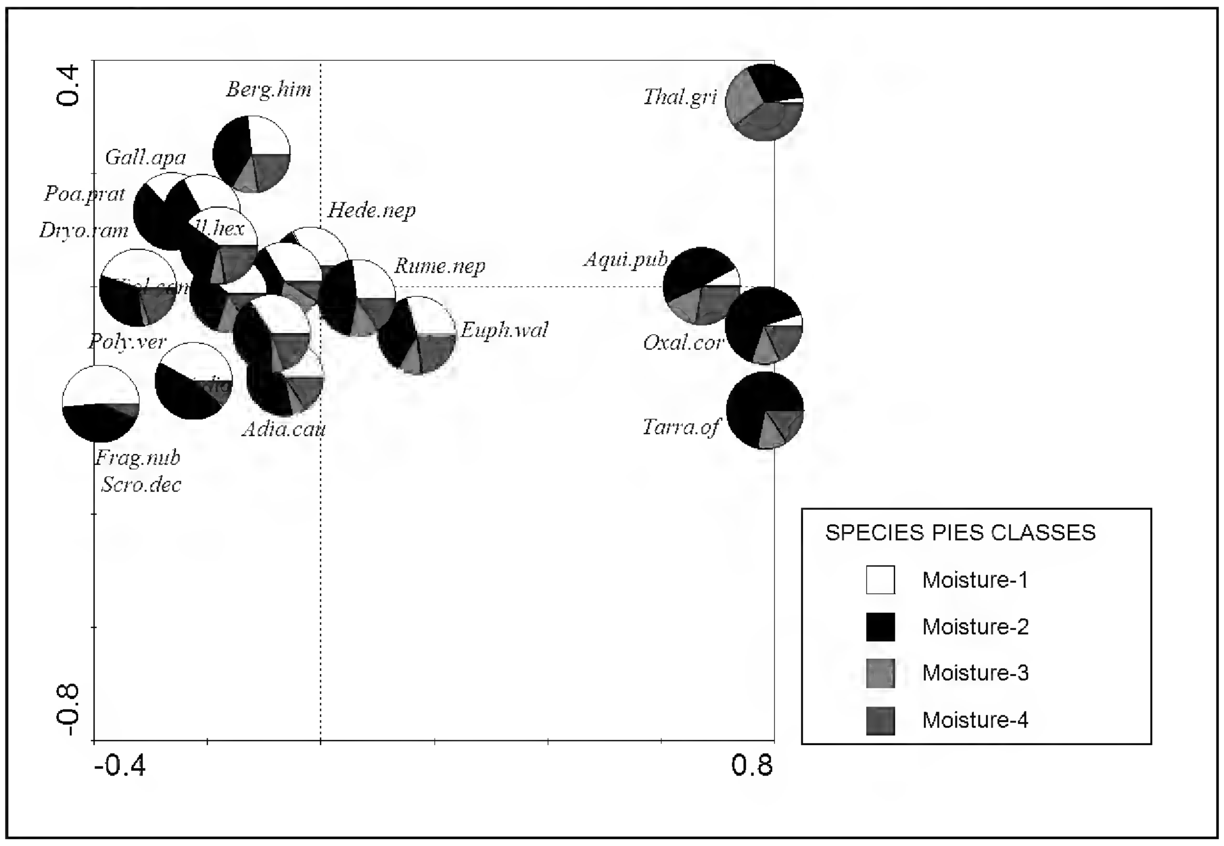


Figure 4: Pie symbols plot (Both Zones) of species over classes of samples with different soil moisture.

DISCUSSIONS

Multivariate analysis technique called Canonical Correspondence Analysis (CCA) was used in this study in Ayubia National Park to identify the correlation between species occurrence/abundance and environmental variables. This ordination technique assumed that species abundance was unimodally distributed along environmental gradients. Species richness is mostly correlated with soil moisture and pH. Organic matter was the factor strongly correlated with species richness in dense vegetation (Welle et al., 2003). Soil pH can also be correlated with species richness, high species richness results in declining as pH declines (Gough et al., 2000; Roem & Berendse, 2000). The study area was divided in different zones i.e. Zone 1 and Zone 2, CCA was applied to classify the species richness. Results of Zone 1 were completely different from Zone 2 as the soil moisture and organic matter were highest in Zone 2 due to dense vegetation. Same results were revealed when overall species data were employed for CCA analysis. The most of the researches revealed that high temperature as well as irrigation manipulations exhibit unusual level of impact on diverse taxa moreover, they may influence species abundance and species richness in a complementary way. Soil is the most species rich component in many terrestrial ecosystems (Adams & Wall, 2000; André et al., 2002) and also plays significant function within ecosystem, affecting processes including plant growth as well as decomposition (Coleman & Hendrix, 2000). Results of present study stress the need of conservation and preservation of native flora.

REFERENCES

Adams G.A. & Wall D.H., 2000. Biodiversity above and below the surface of soils and sediments: linkages and implications for global change. Bioscience, 50: 1043–1048.

Ahmad S.S., 2009. Ordination and classification of herbaceous vegetation in Margalla Hills National Park Islamabad Pakistan. Biolological Diversity and Conservation, 2: 38-44.

Ahmad S.S., 2011. Canonical Correspondence Analysis of the relationships of roadside vegetation to its edaphic factors: a case study of Lahore-Islamabad motorway (M-2). Pakistan Journal of Botany, 43: 1673-1677.

Ahmad S.S., Fazal S., Valeem E.E., Khan Z.I., Sarwar G. & Iqbal Z., 2009. Evaluation of ecological aspects of roadside vegetation around Havalian city using Multivariate techniques. Pakistan Journal of Botany, 41: 53-60.

Ahmad S.S., Wahid A. & Akbar K. F., 2010a. Multivariate classification and data analysis of vegetation along Motorway (M-2), Pakistan. Pakistan Journal of Botany, 42: 1173-1185.

Ahmad I., Ahmad M.S.A., Hussain M., Ashraf M. & Hameed M.Y. & Hameed M., 2010b. Spatiotemporal Aspects of plant community structure in Open Scrub Rangelands of Sub-Mountainous Himalayan Plateaus. Pakistan Journal of Botany, 42: 3431-3440.

Allen S.E., 1974. Chemical analysis of ecological materials. Blackwell scientific publications, Oxford. London, 565 pp.

André H.M., Ducarme X. & Lebrun P., 2002. Soil biodiversity: Myth, reality or conning? Oikos, 96: 3-24.

Coleman D.C. & Hendrix P.F., 2000. Invertebrates as Webmasters in Ecosystems. Institute of Ecology, CABI Publishing, New York, 352 pp.

Farooque M., 2002. Management Plan of Ayubia National Park 2002-2007. Natural resource conservation project, Galiat, Abbotabad, 11-12.

Gough L., Shaver G.R., Carrol J., Royer D.L. & Laundre J.A., 2000.Vascular plant species richness in Alaskan arctic tundra: The importance of soil pH. Journal of Ecology, 88: 54-66.

Hill M.O. & Gauch H.G., 1980. Detrended correspondence analysis, an improved ordination technique. Vegetatio, 42: 47-58.

Jabeen T. & Ahmad S.S., 2009. Multivariate analysis of environmental and vegetation data of Ayub National Park, Rawalpindi. Soil and Environment, 28: 106-112.

Kashian D.M., Barnes B.V. & Walker W.S., 2003. Ecological species groups of landform-level ecosystems dominated by jack pine in northern Lower Michigan, USA. Plant Ecology, 166: 75-91.

Kent M. & Coker P., 1995. Vegetation Description and Analysis: a practical approach. Belhaven Press, London, 363 pp.

Nasir Y J. & Rafiq R A., 1995. Wild Flowers of Pakistan. Oxford University Press., Karachi, 298 pp.

Nikolskii N.N., 1963. Practical soil sciences. Tech Services, U.S., Department of Commerce, Washington, 240 pp.

Pirzada H. Ahmad S.S. & Audil R., 2009. Monitoring of soil lead pollution using roadside plants (*Dalbergia sissoo* and *Cannabis sativa*) utilizing multivariate analysis. Pakistan Journal of Botany, 41: 1729-1736.

Roem W.J. & Berendse F., 2000. Soil acidity and nutrient supply ratio as possible factors determining changes in plant species diversity in grassland and healthland communities. Biological conservation, 92: 151-161.

Welle V., Marlies E.W., Peter V., Gaius R. & Frank B., 2003. Factors determining the species richness in Alaska arctic tundra. Journal of Vegetation Science, 14: 711-720.

Zhang J.T., 2004. Quantitative Ecology. Science Press, Beijing, China: 516-522.

Biodiversity Journal, 2011, 2 (3): 121-144

A check list of the freshwater algal flora of Sierra Leone, Tropical West Africa. I. Cyanophyceae to Conjugatophyceae (exclusive of Bacillariophyceae)

Silvia Alfinito

Department of Environmental Biology, University of Rome “La Sapienza”, 00185 Rome, Italy; e-mail: silvia.alfinito@uniroma1.it

ABSTRACT Up to present, this is the first check list of the non marine algal flora of Sierra Leone. In this first part 468 taxa, exclusive of diatoms, are reported. For each taxa, the updated nomenclature and the finding localities with references are given.

KEY WORDS Check list, freshwater algae, Sierra Leone, Tropical Africa.

Received 27.05.2011; accepted 10.08.2011; printed 30.09.2011

INTRODUCTION

The first publication on the freshwater algal flora of Sierra Leone (Tropical West Africa) dates back to O’Meara (1876) who, during a meeting of the Dublin Microscopical Club, reported the finding of some *Coscinodiscus* (centric diatoms) in samples from Rockett River. After that only in 1958 Woodhead & Tweed in a check list of the algal flora of the West Africa reported some algae themselves collected in Sierra Leone, Sula Hills (Woodhead & Tweed, 1958); in subsequent papers these authors (1959; 1960) described several new species, that for the extremely poor quality of iconography were considered suspected and in any case invalidly published (Grönblad et al., 1968; Gerrath & Denny, 1979). All the records of Woodhead & Tweed (loc. cit.) except for the newly but invalid described taxa, were not substantiated by any illustration. For all these reasons in this check list the species reported in their papers will not be taken into account.

The first data that can be considered valid for the compilation of this check list are those reported in Mölder (1962) who listed several diatoms collected in Kangari and Sula. Brandham (1967) described a new species of *Micrasterias* from the samples in the collection of Woodhead & Tweed; Grönblad et al. (1968) published the desmid flora of Njala and Kabala, with several species new to science and Whitton (1968) a list of Cyanophyceae from the North and North West Area.

From 1979 to 1994 several researches were carried out on the freshwater algal flora of Sierra Leone: Alfinito & Mazzoni (1986); Alfinito et al. (1989; 1990; 1994); Carter & Denny (1982; 1987; 1992); Gerrath & Denny (1979; 1980; 1980a; 1988; 1989); Fumanti (1994); Fumanti et al. (1990); Mazzoni (1986); Ricci & Alfinito (1994) and Ricci et al. (1990).

Altogether 14 taxa were described as new:

Cystodinium sonfonense Gerrath et Denny, 1980

Actinotaenium wollei (Grönbl.) Teiling v. *latius* Croasdale in Grönblad et al. 1968

Cosmarium exiguum Archer f. *ocellatum* Grönblad et Croasdale in Grönblad et al., 1968

Cosmarium rossi Ricci in Ricci & Alfinito, 1994

Cosmarium wenmanae Croasdale in Grönblad et al., 1968

Docidium lomaense Alfinito et Mazzoni, 1986

Euastrum divaricatum Lundell v. *ugandanum* Grönblad in Grönblad et al., 1968

Micrasterias echinata Brandham, 1967

Micrasterias mahabuleshwarensis Hobson v. *comperei* Couté et Rousselin v. *semireducta* Scott et Croasdale in Grönblad et al., 1968

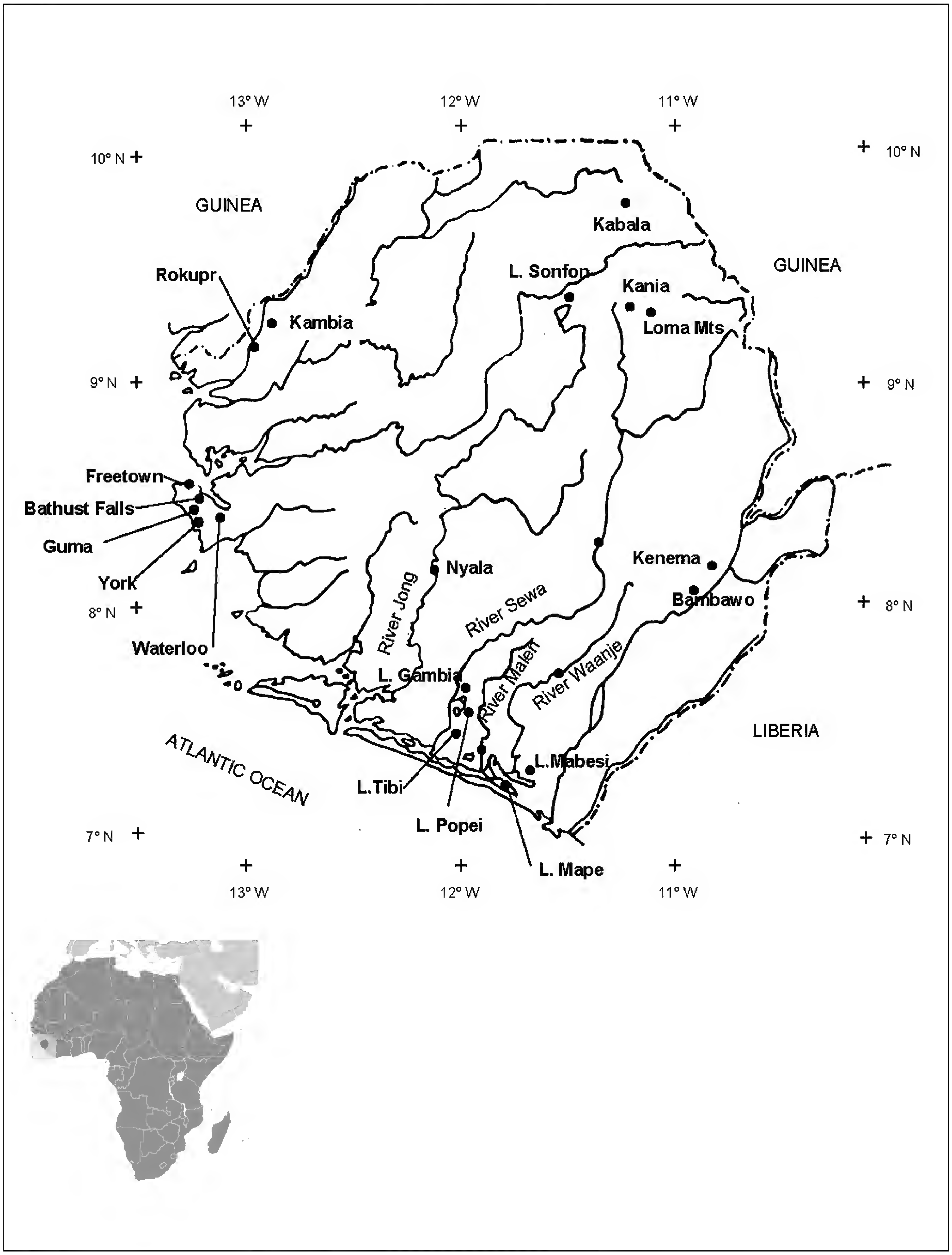


Figure 1. Map of Sierra Leone showing the investigated sites.

Penium cylindraceum Förster f. *majus* Croasdale in Grönblad et al., 1968

Staurastrum contectum Turner f. *concavum* Scott et Croasdale in Grönblad et al., 1968

Staurastrum histrix Ralfs v. *granulatum* Ricci in Ricci et al., 1990

Staurastrum setigerum Cleve v. *pectinatum* West et West f. *paucispiniferum* Croasdale in Grönblad et al., 1968.

Staurastrum spiculiferum Borge v. *glabrum* Gerrath et Denny, 1988

MATERIAL AND METHODS

This first part of the check list, concerning 25 localities, lists all the algal groups, exclusive of diatoms, for a total of 468 taxa, distributed as follows in the different algal classes: Cyanophyceae: 38; Chrysophyceae: 2; Xanthophyceae: 1, Raphidophyceae: 1; Cryptophyceae: 2; Dinophyceae: 7; Euglenophyceae: 73; Prasinophyceae: 1; Chlorophyceae: 55; Conjugatophyceae: 288.

All the taxa reported only as "sp." or with "cfr." but with an iconographic documentation, were taken into account. Those genera cited only as "spp." were counted only as genera.

In the check list, the classification of the algae, given in van den Hoek et al. (1995), was followed at classes level.

For taxa nomenclature checking references used were:

Cyanophyceae: Anagnostidis & Komárek, 1989, 1990; Komárek & Anagnostidis, 1999; 2005; Komárek & Hauer, 2011.

Chrysophyceae: Starmach, 1985.

Xanthophyceae: Ettl, 1978.

Raphidophyceae and Cryptophyceae: Huber-Pestalozzi, 1950.

Dinophyceae: Popovský & Pfiester, 1990.

Euglenophyceae: Huber-Pestalozzi, 1955.

Prasinophyceae: Ettl, 1983.

Chlorophyceae, Volvocales: Ettl, 1983.

Chlorophyceae, Tetrasporales: Ettl & Gärtner, 1988.

Chlorophyceae, Chlorococcales: Komárek & Fott, 1983.

Chlorophyceae, Chaetophorales: Printz, 1964.

Chlorophyceae, Oedogoniales: Mrozińska, 1985.

Chlorophyceae, Conjugatophyceae: Coesel & Meester, 2007; Croasdale et al., 1983; Förster, 1982; Prescott et al., 1972; 1975; 1977; 1981; 1982; Růžička, 1977; 1981.

Investigated localities

Bambawo, stream at
Bathurst Falls (Fig. 2)
Freetown
Fourah Bay College, Freetown.
Guma Dam (Fig. 3)
Kabala, river at
Kambia
Kania, pools near (Fig. 4)
Kenema, swamp at
Lake Gambia
Lake Mabesi
Lake Malen
Lake Mape
Lake Popei
Lake Sonfon
Lake Tibi
Loma Mnts, Peak Bintimani (Figs. 5-7)
Njala
River Jong
River Malen
River Sewa
River Waanje
Rokupr
Waterloo
York, swamp at (Fig. 8)

References for Sierra Leone freshwater algae (numbers in bracket after each locality)

1: Brandham, 1967.
2: Grönblad et al., 1968.
3: Whitton, 1968.
4: Gerrath & Denny, 1979.
5: Gerrath & Denny, 1980.
6: Gerrath & Denny, 1980a.
7: Alfinito & Mazzoni, 1986.
8: Gerrath & Denny, 1988.
9: Alfinito et al., 1989.
10: Gerrath & Denny, 1989.
11: Alfinito et al., 1990.
12: Ricci et al., 1990.
13: Ricci & Alfinito, 1994.

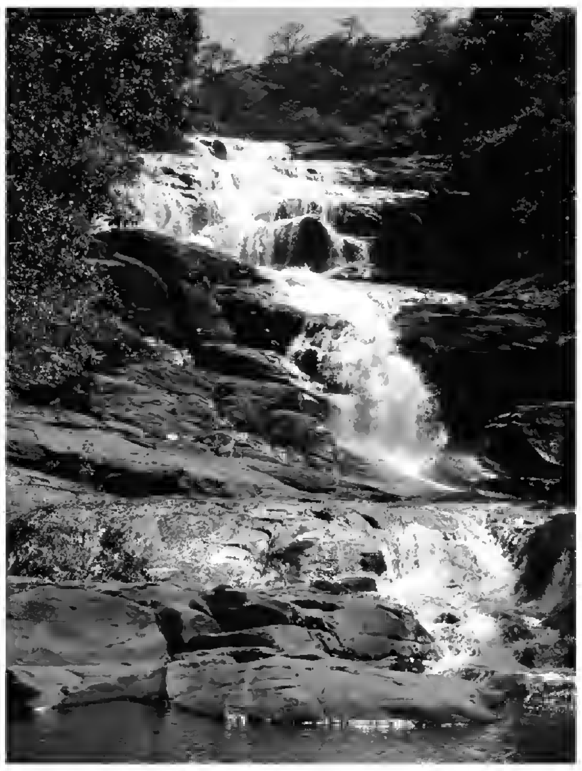


Fig.2

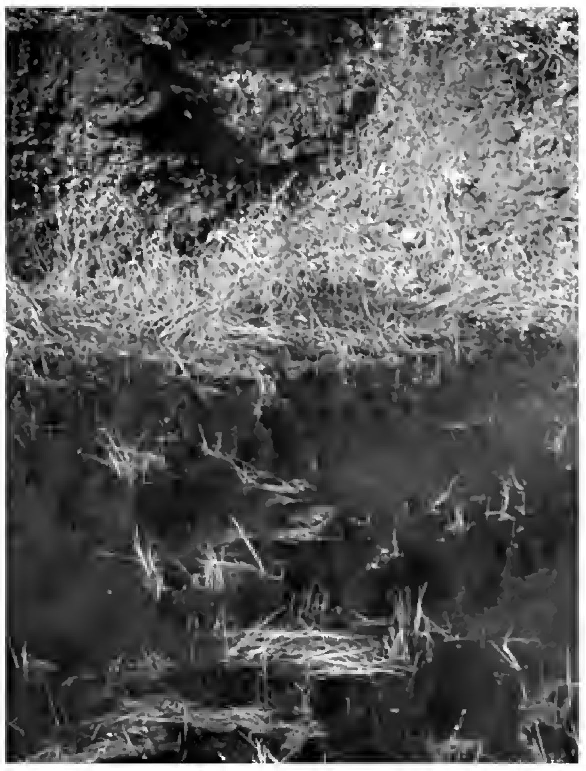


Fig.3


Fig.4


Fig.5


Fig.6


Fig.7


Fig.8

Figure 2. Bathurst Falls (photo W. Rossi).
Figure 3. Guma Dam, pool on lateritic soil (photo W. Rossi).
Figure 4. Little pools near Kania (photo W. Rossi).
Figure 5. Loma Mountains, Peak Bintimani (photo W. Rossi).
Figure 6. Loma Mountains, NE slope of Peak Bintimani, sampling area (photo W. Rossi).
Figure 7. Loma Mountains, NE slope of Peak Bintimani, 1650 m a.s.l., small pools on granitic rock (photo W. Rossi).
Figure 8. Swamp near York (photo W. Rossi).

CHECK LIST

CYANOPHYCEAE

CHROOCOCCALES

Aphanocapsa Nägeli, 1849

A. elachista West et West, 1894 - Lake Tibi, Lake Sonfon (6)

Aphanothece Nägeli, 1849

A. stagnina (Sprengel) A. Braun, 1863 - Kambia (3); Lake Sonfon (6)

Chroococcus Nägeli, 1849

C. turgidus (Kütz.) Nägeli, 1849 - Without localities (6)

Eucapsis Clements et Shantz, 1909

E. alpina Clements et Shantz, 1909 - Lake Sonfon (6)

Gloeocapsa Kützing, 1843

G. aeruginosa Kützing, 1843 - Waterloo (3)

Merismopedia Meyen, 1839

M. punctata Meyen, 1839 - Lake Mape, River Jong, River Sewa, Lake Popei, Lake Sonfon (6)

NOSTOCALES

Anabaena Bory ex Bornet et Flahault, 1886

A. fuellebornii Schmidle, 1902 - Guma Dam (3)
A. promecespora Fremy, 1930 forma - Lake Popei (6)
A. torulosa (Carm.) Lagerheim ex Bornet et Flahault, 1888 - Rokupr (3)
Anabaena spp. - Lake Mape, River Jong, Lake Popei, Lake Sonfon (6)

Calothrix Agardh ex Bornet et Flahault, 1886

C. stagnalis Gomont, 1895 - River Jong, Bambawo, Lake Sonfon (6)

Cylindrospermum Kützing ex Bornet et Flahault, 1888

C. majus Kützing ex Bornet et Flahault, 1888 - Freetown (3)
C. licheniforme (Bory) Kützing ex Bornet et Flahault, 1888 - Freetown (3)

Nodularia Mertens ex Bornet et Flahault, 1886

N. harveyana Thuret ex Bornet et Flahault, 1888 - Lake Tibi (6)

Scytonema Agardh ex Bornet et Flahault, 1886
S. hyalinum Gardner, 1927 - Freetown (3)

Tolypothrix Kützing ex Bornet et Flahault, 1886

T. byssoidea (Hassal) Kirchner, 1878 - Fourah Bay College (3)
T. distorta Kütz. ex Born. et Flah., 1888
v. ***symplocoides*** Hansgirg, 1892 - Fourah Bay College (3)
T. fragilis (Gardner) Geitler, 1932 - Rokupr (3)
T. mangini (Frémy) Geitler, 1932 - Guma Dam (3)

OSCILLATORIALES

Arthrospira Stitzenberger ex Gomont, 1892

A. gigantea (Schmidle) Anagnostidis, 1998 - Lake Gambia, Lake Popei, Lake Mabesi (6)
= *Spirulina gigantea* Schmidle, 1902
A. jenneri Stitzenb. ex Gomont, 1892 - Lake Sonfon (6)
= *Spirulina jenneri* (Stizenb.) Geitler, 1925

Geitlerinema (Anagn. et Komárek) Anagnostidis, 1989

G. calcuttense (Bisw.) Anagnostidis, 1989 - Guma Dam (3)
= *Oscillatoria calcuttensis* Biswas, 1932
G. splendidum (Grev. ex Gom.) Anagnostidis, 1989 - Freetown (3); Lake Sonfon (6).
= *Oscillatoria splendida* Greville ex Gomont, 1892

Lyngbya Agardh ex Gomont, 1892

L. birgei G.M. Smith, 1916 - Lake Mape, River Jong (6)
L. corticicola Brühl et Biswas, 1923 - Kambia (3)
L. martensiana Meneghini ex Gomont, 1892 - Lake Mape, Bambawo, Lake Sonfon (6)
L. nigra Agardh ex Gomont, 1892 - Kambia (3)
L. spiralis Geitler, 1932 - Rokupr (3)

Oscillatoria Vaucher ex Gomont, 1892

O. variabilis Rao, 1936 - Kambia (3)
= *O. raoi* De Toni, 1939
NOTE: *O. variabilis* is one of the unrevised species of *Phormidium* in Komárek & Anagnostidis (2005).
O. princeps Vaucher ex Gomont, 1892 - Lake Mape, Lake Sonfon (6)
O. subbrevis Schmidle, 1901 - Lake Mape, Lake Mabesi, River Jong, River Sewa, Lake Sonfon (6)
O. tenuis Agardh ex Gomont, 1892 - Lake Popei, River Jong, Lake Sonfon (5)

Phormidium Kützing ex Gomont, 1892

P. digueti (Gom.) Anagnostidis et Komárek, 1988 - Lake Sonfon (6)
= *Lyngbya digueti* Gomont, 1895
P. kuetzingianum (Kirchn.) Anagnostidis et Komárek, 1988 - Kambia (3)
= *Lyngbya kuetzingiana* Kirchner, 1878

P. okeni (Agardh ex Gom.) Anagnostidis et Komárek, 1988 - Freetown (3)
= *Oscillatoria okeni* Agardh ex Gomont, 1892

Spirulina Turpin ex Gomont, 1892

S. major Kützing ex Gomont, 1892 - York (3); Lake Mape, Lake Popei (6).

Symplocastrum (Gomont) Kirchner, 1898

S. muelleri (Nägeli ex Gomont.) Anagnostidis, 2001 - Kambia (3)
=*Schizothrix muelleri* Nägeli ex Gomont, 1892

STIGONEMATALES

Hapalosiphon Nägeli in Kützing ex Bornet et Flahault, 1886

H. arboreus West et West, 1894 - Lake Sonfon (6)
H. flexuosus Borzì, 1892 - Lake Popei (6)

C H R Y S O P H Y C E A E

OCHROMONADALES

Dinobryon Ehrenberg, 1835

D. sertularia Ehrenberg, 1838 - Lake Tibi (6)
D. sertularia v. ***protuberans*** (Lemm.) Krieger, 1930 - Lake Gambia, River Waanje, Lake Tibi, Lake Mape (6)

X A N T H O P H Y C E A E

MISHOCOCCALES

Ophiocytium Nägeli, 1849

O. majus Nägeli, 1849 - Lake Sonfon (6)

R A P H I D O P H Y C E A E

VACUOLARIALES

Gonyostomum Diesing, 1866

G. semen (Ehr.) Diesing, 1866 - Lake Sonfon (6)

C R Y P T O P H Y C E A E

CRYPTOMONADALES

Cryptomonas Ehrenberg, 1831

C. marssonii Skuja, 1848 - River Malen, Lake Sonfon (6)
C. ovata Ehrenberg, 1832 - Lake Mape, River Waanje, Lake Popei, Lake Tibi, River-Jong, Lake Sonfon (6)

D I N O P H Y C E A E

PERIDINIALES

Ceratium Schrank, 1793

C. brachyceros Daday, 1907 - Lake Sonfon (6)
C. hirundinella (O. F. Müller) Dujardin, 1841 forma - Lake Mape, River Waanje, River Jong (6)

Gymnodinium Stein, 1878

G. fuscum (Ehr.) Stein, 1878 - Lake Tibi, Lake Gambia (6)

Peridinium Ehrenberg, 1832

P. umbonatum Stein, 1883 - Lake Mape, River Waanje, Lake Gambia (6)
= *P. inconspicuum* Lemmermann, 1899

DINOCOCCALES

Cystodinium Klebs, 1912

C. sonfonense Gerrath et Denny, 1980 - Lake Sonfon (6)

Stylodinium Klebs, 1912

S. globosum Klebs, 1912 - Lake Sonfon (6)
= *S. cerasiforme* Pascher, 1927

Tetradinium Klebs, 1912

T. javanicum Klebs, 1912 - Lake Sonfon (6)

E U G L E N O P H Y C E A E

EUGLENALES

Astasia Dujardin, 1841

A. torta Pringsheim, 1942 - Lake Sonfon (4)

Entosiphon Stein, 1878

E. sulcatum (Dujardin) Stein, 1878 - Lake Sonfon (4)
Entosiphon sp. - Lake Sonfon (4)

Euglena Ehrenberg, 1838

E. acus Ehrenberg, 1838 - Lake Tibi, Lake Mabesi, Lake Sonfon (4)
E. charkowiensis Swirenko, 1913 - River Waanje, Lake Gambia, Lake Tibi, Lake Sonfon (4)
E. geniculata Dujardin, 1841 - Lake Sonfon (4)
E. gracilis Klebs, 1883 - Lake Sonfon (4)
E. limnophila Lemm., 1898 v. ***lemmermannii*** Drezelpolsky, 1925 - Lake Sonfon (4)
E. oblonga Schmitz, 1884 - Lake Sonfon (4)
E. spirogyra Ehrenberg, 1838 v. ***suprema*** Skuja, 1932 - Lake Sonfon (4)
E. viridis Ehrenberg, 1830 - Lake Sonfon (4)
Euglena sp. 1 - Lake Sonfon (4)
Euglena sp. 2 - Lake Malen (4)

Gyropaigne Skuja, 1939

G. lefevrei Bourrelly et Georges, 1951 - Lake Sonfon (4)

Lepocinclis Perty, 1849

L. acuta Prescott, 1949 - Lake Sonfon (4)
L. fusiformis (Carter) Lemm. em. Conrad, 1934 v. ***fusiformis*** f. ***fusiformis*** - Lake Sonfon (4)
L. fusiformis v. ***fusiformis*** f. ***lemmermannii*** (Conrad) Huber-Pestalozzi, 1955 - Lake Sonfon (4)
= *L. fusiformis* (Carter) Lemm., 1901 v. *lemmermanni* Conrad, 1935
L. fusiformis v. ***amphirhynchus*** Nygaard, 1949 - Lake Sonfon (4)
L. marssonii Lemmermann em. Conrad, 1935 - Lake Sonfon (4)
L. ovum (Ehr.) Lemmermann, 1910 v. ***ovum*** - Lake Sonfon (4)
L. ovum v. ***angustata*** (Defl.) Conrad, 1935 - Lake Tibi (4)
L. ovum v. ***globula*** (Perty) Lemmermann, 1910 - Lake Sonfon (4)
L. texta (Dujardin) Lemmermann em. Conrad, 1935 - Lake Sonfon (4)
Lepocinclis sp. - Lake Sonfon (4)

Menoidium Perty, 1852

M. gracile Playfair, 1921 - Lake Sonfon (4)

Notosolenus Stokes, 1884

Notosolenus sp. - Lake Sonfon (4)

Phacus Dujardin, 1841

P. acuminatus Stokes, 1885 forma - Lake Sonfon (4)
P. atraktoides Pochmann, 1942 - Lake Sonfon (4)
P. brachykentron Pochmann, 1942 forma - Lake Sonfon (4)
P. brevicaudatus (Klebs) Lemmermann, 1910 - Lake Gambia (4)
P. contortus Bourrelly, 1952 v. ***complicatus*** Bourrelly, 1952 - Lake Sonfon (4)
P. ephippion Pochmann, 1942 - Lake Mape (4)
P. glaber (Defl.) Pochmann, 1942 - Lake Sonfon (4)
P. hamatus Pochmann, 1942 - Lake Sonfon (4)

P. inflexus (Kisselew) Pochmann, 1942	- Lake Sonfon (4)
P. longicauda (Ehr.) Dujardin, 1841 v. ***longicauda***	- Lake Sonfon (4)
P. longicauda v. ***major*** Swirenko, 1915	- Lake Sonfon (4)
P. longicauda v. ***rotunda*** (Pochm.) Huber-Pestalozzi, 1955	- Lake Mabesi (4)
P. meson Pochmann, 1942	- Lake Mabesi (4)
P. onyx Pochmann, 1942	- Lake Sonfon (4)
P. orbicularis Hübner, 1896	- River Waanje, Lake Sonfon (4)
P. pleuronectes (Müller) Dujardin, 1841 forma	- Lake Mabesi, Lake Sonfon (4).
P. polytrophos Pochmann, 1942	- Lake Sonfon (4)
P. pseudonordstedtii Pochmann, 1942 v. ***minuscola*** (Conrad) Huber-Pestalozzi, 1955	- Lake Sonfon (4)
P. stokesii Lemmermann, 1910	- Lake Sonfon (4)
P. tortus (Lemm.) Skvortzow, 1928	- Lake Malen, Lake Sonfon (4)
P. undulatus (Skvortz.) Pochmann, 1942	- Lake Sonfon (4)
P. viguieri Allorge et Lefévre, 1930	- Lake Sonfon (4)
Phacus sp. 1	- Lake Sonfon (4)
Phacus sp. 2	- Lake Sonfon (4)

Strombomonas Deflandre, 1930

S. fluviatilis (Lemm.) Deflandre, 1930	- Lake Mabesi (4)
S. schauinslandii (Lemm.) Deflandre, 1930	- Lake Mabesi, Lake Malen (4)
S. tambowika (Swir.) Deflandre, 1930	- Lake Mabesi (4)
S. tetraptera Balech et Dastugue, 1937	- Lake Mabesi (4)
S. verrucosa (Daday) Deflandre, 1930 v. ***zmiewika*** (Swir.) Deflandre, 1930	- Lake Mabesi (4)

Trachelomonas Ehrenberg, 1833

T. abrupta Swirenko em. Defl., 1926	- River Waanje, River Jong, Lake Sonfon (4)
T. armata (Ehr.) Stein, 1833	- Lake Mabesi, Lake Sonfon (4)
T. crispa Balech, 1944	- Lake Sonfon (4)
T. dubia Swirenko em. Deflandre, 1926	- Lake Sonfon (4)
T. globularis (Awer.) Lemmermann, 1910 v. ***punctata*** Skvortzow, 1917	- Lake Sonfon (4)
T. hispida (Perty) Stein, 1883 v. ***hispida***	- Lake Sonfon (4)
T. hispida v. ***crenulatocollis*** (Maskell) Lemmermann, 1910	- Lake Sonfon (4)
T. hispida v. ***duplex*** Deflandre, 1926	- River Jong (4)
T. intermedia Dangeard, 1902	- Lake Sonfon (4)
T. janczewskii Drezelp., 1921 var. ***minor*** Drezelpolski, 1925	- Lake Sonfon (4)
T. naviculiformis Defl., 1926 v. ***bourrelyi*** Huber-Pestalozzi, 1955	- Lake Sonfon (4)
T. oblonga Lemmermann, 1899	- Lake Mape, Lake Sonfon (4)
T. scabra Playfair, 1915 forma	- Lake Mabesi (4)
T. speciosa Deflandre, 1926	- Lake Sonfon (4)
T. superba Swirenko em. Deflandre, 1926	- Lake Sonfon (4)
T. volvocinopsis Swirenko, 1914	- Lake Mape, Lake Sonfon (4)
T. woycickii Koczwara, 1915	- Lake Sonfon (4)
T. zingeri Roll, 1925	- Lake Sonfon (4)

P R A S I N O P H Y C E A E

POLYBLEPHARIDALES

Pyramimonas Schmarda, 1849

P. tetrarynchus Schmarda, 1849	- Lake Sonfon (5)

C H L O R O P H Y C E A E

VOLVOCALES

Chlamydomonas Ehrenberg, 1833

C. pseudotarda Bourrelly, 1951 - Lake Sonfon (5)
Chlamydomonas sp. - Lake Sonfon (5)

Eudorina Ehrenberg, 1831

E. elegans Ehrenberg, 1831 - Lake Malen, River Jong (5)

Pandorina Bory, 1824

P. morum (O. F. Müller) Bory, 1824 - River Jong, Lake Sonfon (5)

TETRASPORALES

Chlamydocapsa Fott, 1972

C. ampla (Kütz.) Fott, 1972 - Lake Sonfon (5)
= *Gloeocystis ampla* (Kütz.) Lagerheim, 1883

Stylosphaeridium Geitler et Gimesi, 1925

Stylosphaeridium stipitatum (Bachm.) Geitler et Gimesi, 1925 - Lake Sonfon (5)
= *Characium stipitatum* (Bachm.) Wille, 1911

CHLOROCOCCALES

Ankistrodesmus Corda, 1838

A. bibraianus (Reinsch) Koršikov, 1953 - Lake Mape, Lake Gambia, Lake Tibi, Lake Popei, Lake Sonfon (5)
A. fusiformis Corda, 1838 - Lake Tibi, Lake Popei, Lake Sonfon (5)
A. gracilis (Reinsch) Koršikov, 1953 - Lake Sonfon (5)

Botryococcus Kützing, 1849

B. braunii Kützing, 1849 - River Jong, Lake Gambia, Lake Popei, Lake Sonfon (5)

Characium A. Braun in Kützing, 1849

C. ensiforme Hermann, 1863 - Lake Gambia (5)
= *C. ambiguum* Hermann, 1863
C. rostratum Reinhard ex Printz, 1914 - Lake Sonfon (5)

Coelastrum Nägeli, 1849

C. cambricum Archer, 1868 - River Waanje, River Malen, Lake Gambia, Lake Tibi, Lake Popei, Lake Mabesi, Lake Mape, Lake Sonfon (5)

C. sphaericum Nägeli, 1849	- Lake Tibi, Lake Popei, River Jong, Lake Sonfon (5)
Coenochloris Koršikov, 1953	
C. pyrenoidosa Koršikov, 1953	- Lake Tibi (5)
Crucigenia Morren, 1830	
C. quadrata Morren, 1830	- Lake Tibi (5)
Dictyosphaerium Nägeli, 1849	
D. pulchellum Wood, 1872	- Lake Gambia, Lake Popei, Lake Tibi, River Jong, River Malen, Lake Sonfon (5)
Dimorphococcus A. Braun, 1855	
D. lunatus A. Braun, 1855	- Lake Tibi, Lake Mape, Lake Sonfon (5)
Gloeocystis Nägeli, 1849	
G. major Gerneck ex Lemmermann, 1915	- Lake Sonfon (5)
Gloeocystis sp.	- Lake Gambia (5)
Kirchneriella Schmidle, 1893	
K. lunaris (Kirchner) Möbius, 1894	- Lake Tibi, Lake Sonfon (5)
Micractinium Fresenius, 1858	
M. pusillum Fresenius, 1858	- Lake Sonfon (5)
Monoraphidium Komárková-Legnerová, 1969	
M. contortum (Thuret) Komárková-Legnerová, 1969	- Lake Sonfon (5)
M. convolutum (Corda) Komárková-Legnerová, 1969	- Lake Sonfon (5)
M. griffithii (Berkeley) Komárková-Legnerová, 1969	- Lake Tibi (5)
M. irregulare (G. M. Smith) Komárková-Legnerová, 1969	- Lake Sonfon (5)
Oocystis A. Braun, 1855	
O. borgei Snow, 1903	- Lake Gambia, Lake Sonfon (5).
O. solitaria Wittrock, 1879	- Lake Sonfon (5).
= *O. crassa* Wittrock, 1880	
Palmodictyon Kützing, 1845	
P. lobatum Koršikov, 1953	- Lake Sonfon (5)
Pediastrum Meyen, 1829	
P. angulosum (Ehr.) Meneghini, 1840 v. ***asperum*** Sulek, 1969	- River Waanje, River Jong, River Malen, Lake Mape, Lake Popei, Lake Tibi (5)
P. biradiatum Meyen, 1829	- River Waanje, Lake Sonfon (5)

P. boryanum (Turpin) Meneghini, 1840 - River Waanje, River Malen, Lake Mape, Lake Sonfon (5)

P. duplex Meyen, 1829 - River Waanje, River Jong, River Malen, Lake Mape (5)

P. tetras (Ehr.) Ralfs, 1844 - River Waanje, River Jong, River Sewa, Lake Tibi, Lake Gambia, Lake Popei, Lake Sonfon (5)

Scenedesmus Meyen, 1829

S. acuminatus (Lagerh.) Chodat, 1902 - River Jong, River Malen, Lake Mape, Lake Sonfon (5)

S. armatus Chodat, 1913 - River Malen, Lake Mape, Lake Sonfon (5)

S. brasiliensis Bohlin, 1897 - Lake Sonfon (5)

S. ecornis (Ehr.) Chodat, 1926 - Lake Sonfon (5)

S. gutwinskii Chodat, 1926 v. ***heterospina*** Bodrogsközy, 1950 - Lake Sonfon (5)

S. kissii Hortobágy, 1975 - Lake Tibi, Lake Popei, River Jong (5)
= *S. quadricauda* (Turp.) Brebisson, 1835 v. *biornatus* Kiss, 1939

S. quadricauda (Turpin) Brébisson, 1835 - River Waanje, Lake Mape, Lake Tibi, Lake Gambia, River Jong, Lake Popei (5)

Sphaerocystis Chodat, 1897

S. schroeteri Chodat, 1897 - River Jong , Lake Mape, Lake Mabesi, Lake Sonfon (5)

Tetraedron Kützing, 1845

T. regulare Kützing, 1845 - Lake Sonfon (5)

Tetrallantos Teiling, 1916

T. lagerheimii Teiling, 1916 - Lake Tibi, Lake Sonfon (5)

Westella de Wildeman, 1897

W. botryoides (W. West) de Wildeman, 1897 - Lake Sonfon (5)

CHAETOPHORALES

Chaetosphaeridium Klebahn, 1892

C. pringsheimii Klebahn, 1893 - Lake Tibi, Lake Popei (5)

Microspora Thuret, 1850

M. aequabilis Wichmann, 1937 v. ***minor*** Wichmann, 1937 - Lake Sonfon (5)

Microthamnion Nägeli, 1849

M. strictissimum Rabenhorst, 1863 - Lake Mape, Lake Sonfon (5)

Oligochaetophora G. S. West, 1911

O. simplex G. S. West, 1911 - Lake Sonfon (5)

Ulothrix Kützing, 1836

U. amphigranulata Skuja, 1948 - Lake Sonfon (5)
U. subtilis Kützing, 1845 - Lake Sonfon (5)

Uronema Lagerheim, 1887

U. confervicolum Lagerheim,1887 v. ***africanum*** (Borge) Printz, 1964 - Lake Sonfon (5)
= *U. africanum* Borge, 1928

OEDOGONIALES

Bulbochaete Agardh, 1817

Bulbochaete spp. - Lake Mape, Lake Tibi, Lake Popei, Lake Sonfon (5)

Oedogonium Link, 1820

O. mammiferum Wittrock, 1874 - Lake Sonfon (5)
O. patulum Tiffany, 1934 - Lake Sonfon (5)
O. reinschii Roy ex Cook, 1884 - Lake Sonfon (5)
Oedogonium spp. - River Jong, River Sewa, Lake Mape, Lake Gambia, Lake Tibi, Lake Popei, Lake Sonfon (5)

C O N J U G A T O P H Y C E A E

ZYGNEMATALES

Cylindrocystis Meneghini ex de Bary, 1858

C. brebissonii Menegh. ex de Bary, 1858 v. ***brebissonii*** - Lake Sonfon (5); Kania (9); Bathurst Falls (11); Guma Dam (12); York (13)
C. brebissonii v. ***minor*** West et West, 1902 - Lake Tibi (5)
C. crassa de Bary, 1858 - Lake Sonfon (5)

Mougeotia Agardh, 1824

Mougeotia spp. - Lake Mape, River Jong, Bambawo, Lake Gambia, River Sewa, Lake Tibi, Lake Popei, River Malen, Lake Sonfon (5)

Netrium (Näg.) Itzsigson et Rothe em. Lütkemüller, 1902

N. digitus Itzsigson et Rothe, 1856 v. ***digitus*** - Kabala (2); Njala (2); River Sewa (5); Loma Mnts (7); Kania (9); Bathurst Falls (11)
N. digitus v. ***lamellosum*** (Bréb.) Grönblad, 1920 - Njala (2)
N. digitus v. ***rhomboideum*** Grönblad, 1920 - Njala (2); York (13)
N. oblongum (de Bary) Lütkemüller, 1902 v. ***oblongum*** - Loma Mnts (7)
N. oblongum v. ***cylindricum*** West et West, 1903 - Kabala (2)

Spirogyra Link in Nees, 1820

Spirogyra spp. - Lake Mape, River Jong, River Waanje, Lake Tibi, Lake Popei, Lake Sonfon (5)

DESMIDIALES

Actinotaenium Teiling, 1954

A. capax (Joshua) Teiling, 1954 v. ***minus*** (Schmidle) Teiling, 1954 - Loma Mnts (7)
A. clevei (Lundell) Teiling, 1954 - York (13)
A. crassiusculum (de Bary) Teiling, 1954 - Guma Dam (12); York (13)
A. cucurbita (Bréb.) Teiling, 1954 v. ***cucurbita*** - Njala (2); Loma Mnts (7); Lake Sonfon (8); Kania (9); Bathurst Falls (11); York (13)
A. cucurbita v. ***cucurbita*** f. ***rotundatum*** (Krieger) Teiling, 1954 - Njala (2); York (13)
A. cucurbita (Bréb.) Teiling, 1954 forma - Lake Sonfon (8)
A. cfr. ***cucurbita*** (Bréb.) Teiling, 1954 - Njala (2)
A. cucurbitinum (Bisset) Teiling, 1954 v. ***cucurbitinum*** - Njala (2)
A. cucurbitinum v. ***truncatum*** (Krieger) Teiling, 1954 - York (13)
Actinotaenium sp. ad ***A. phymatosporum*** (Nordst.) = *Penium* sp. Kouwets et Coesel, 1984 acced. ad *P. phymatosporum* Nordstedt, 1876 acced.) - Njala (2)
A. subglobosum (Nordst.) Teiling, 1954 - Njala (2); Kabala (2); Guma Dam (12).
A. wollei (West et West) Teiling, 1954 v. ***wollei*** - York (13)
A. wollei v. ***latius*** Croasdale in Grönblad et al., 1968 - Njala (2); Kabala (2); Lake Sonfon (8); Guma Dam (12)

Bambusina Kützing ex Kützing, 1849

B. borreri (Ralfs) Cleve, 1864 - Guma Dam (12)

Closterium Nitzsch ex Ralfs, 1848

C. abruptum W. West, 1892 v. ***angustissimum*** (Schmidle) Roll, 1915 - Lake Mabesi (10)
C. abruptum v. ***brevius*** (West et West) West et West, 1904 - Loma Mnts (7); Lake Sonfon (8); York (13)
C. acerosum (Schrank) Ehrenberg ex Ralfs, 1848 - River Waanje (10)
C. cfr. ***attenuatum*** Ralfs, 1848 - Njala (2)
C. baillyanum (Bréb.) Brébisson, 1856 - Njala (2)
C. closterioides (Ralfs) Louis et Peeters, 1967 v. ***closterioides*** = *C. libellula* Focke, 1847 v. *libellula,* invalidly published according Růžička (1977) art. 13 ICBN - Njala (2); Kania (9)
C. closterioides v. ***intermedium*** (Roy et Bisset.) Růžička, 1973 = *C. libellula* Focke, 1847 v. *intermedium* (Roy et Bisset) G. S. West, 1914 - Njala (2); Kania (9); River Jong, Lake Tibi (10); Bathurst Falls (11)
C. cornu Ehrenberg ex Ralfs, 1848 - Kania (9)
C. costatum Corda ex Ralfs, 1848 forma - Lake Mabesi (10)
C. cynthia De Notaris, 1867 - Njala (2); Lake Sonfon (8); Kania (9); River Jong, Lake Popei (10); Bathurst Falls (11); Guma Dam (12); York (13)
C. cynthia De Notaris, 1867 forma - Njala (2)
C. dianae Ehrenberg ex Ralfs, 1848 v. ***dianae*** - Njala (2)
C. dianae v. ***minus*** Hieronymus, 1895 - Njala (2); Lake Sonfon (8); River Waanje, Lake Gambia, Lake Tibi, Lake Popei (10); Guma Dam (12); York (13)
C. dianae v. ***pseudodianae*** (Roy) Krieger, 1932 - Njala (2); Kabala (2)

C. directum Archer, 1862 = *C. ulna* Focke, 1847, invalidly published according Růžička (1977) art 13 ICBN	- Bathurst Falls (11)
C. ehrenbergii Menegh. ex Ralfs, 1848 v. ***ehrenbergi***	- Lake Sonfon (8); River Jong (10)
C. ehrenbergii v. ***ehrenbergii*** forma	- Njala (2)
C. ehrenbergii v. ***malinvernianum*** (De Notaris) Rabenhorst, 1868	- Njala (2)
C. gracile Bréb. ex Ralfs, 1848	- Lake Sonfon (8); River Jong, Lake Mabesi (10)
C. incurvum Brébisson, 1856	- River Jong (10)
C. infractum Messikömmer, 1929 v. ***rotundatum*** Grönblad, 1947	- Njala (2)
C. kuetzingii Brébisson, 1856	- Lake Sonfon (8); River Waanje, Lake Mabesi (10)
C. moniliferum (Bory) Ehrenberg ex Ralfs, 1848	- Njala (2); Kabala (2); Bambawo (10)
C. navicula (Bréb.) Lütkemüller, 1902	- Njala (2); Kabala (2); Lake Sonfon (8)
C. nematodes Joshua, 1886	- Njala (2)
C. parvulum Nägeli, 1849 v. ***parvulum***	- Njala (2); Kabala (2)
C. parvulum v. ***angustum*** West et West, 1900	- Njala (2); Lake Popei, River Jong (10)
C. praelongum Brébisson, 1856	- Lake Sonfon (8); Lake Mape, Lake Gambia, Lake Malen (10)
C. psudolunula Borge, 1909	- Njala (2)
C. pusillum Hantzsch in Rabenhorst, 1861 v. ***laticeps*** Grönblad, 1942	- Loma Mnts (7)
C. ralfsii Brébisson ex Ralfs, 1848 v. ***hybridum*** Rabenhorst, 1863	- Lake Sonfon (8); Guma Dam (12)
C. rostratum Ehrenberg ex Ralfs, 1848	- Njala (2)
C. setaceum Ehr. ex Ralfs, 1848	- Njala (2); Kabala (2); Lake Mape, River Jong (10)
C. striolatum Ehrenberg ex Ralfs, 1848	- River Sewa (10); Bathurst Falls (11); Guma Dam (12)
C. subulatum (Kütz.) Brébisson, 1856	- River Jong (10)
C. tumidum Johnson, 1895	- Lake Popei (10)
Closterium sp.	- Njala (2)

Cosmarium Corda ex Ralfs, 1848

C. amoenum Brébisson ex Ralfs, 1848	- Njala (2)
C. anceps Lundell, 1871	- Kania (9)
C. angulosum Brébisson, 1856 v. ***angulosum***	- Lake Sonfon (8)
C. angulosum v. ***concinnum*** (Rabenh.) West et West, 1901	- Lake Sonfon (8)
C. cfr. ***asphaerosporum*** Nordstedt, 1879	- Njala (2)
C. binum Nordstedt, 1880	- Njala (2); Kabala (2); Lake Sonfon (8); Bathurst Falls (11)
C. bioculatum Brébisson ex Ralfs, 1848	- Kania (9)
C. bioculatum Brébisson ex Ralfs, 1848 forma	- Njala (2)
C. bipunctatum Börgesen, 1890	- Kabala (2)
C. boeckii Wille, 1880	- Njala (2)
C. capense (Nordst.) De Toni, 1889 v. ***nyassae*** Schmidle, 1902	- Lake Sonfon (8)
C. candianum Delponte, 1877 = *C. circulare* Reinsch, 1867	- Lake Sonfon (8)
C. commissurale Bréb. ex Ralfs, 1848 v. ***crassum*** Nordstedt, 1870	- Bathurst Falls (11)
C. connatum Brébisson ex Ralfs, 1848 v. ***connatum***	- York (13)
C. connatum v. ***constrictum*** Bourrelly, 1961	- York (13)
C. conspersum Ralfs, 1848 v. ***latum*** (Bréb.) West et West, 1892	- Njala (2)
C. contractum Kirchner, 1872 forma	- Njala (2)
C. decoratum West et West, 1895	- Njala (2); Guma Dam (12); York (13)
C. decoratum West et West, 1895 forma	- Njala (2)
C. emarginatum West et West, 1895 forma	- Lake Sonfon (8)

C. exiguum Archer, 1864 v. ***exiguum*** f. ***ocellatum*** Grönblad et Croasdale in Grönblad et al., 1968 - Njala (2)
C. exiguum v. ***subrectangulum*** West et West, 1908 - York (13)
C. exiguum Archer, 1864 forma 1 - Njala (2)
C. exiguum Archer, 1864 forma 2 - Njala (2)
C. cfr. ***exiguum*** Archer, 1864 - Njala (2)
C. freemanii West et West, 1902 v. ***ocellatum*** Krieger, 1932 forma - Njala (2)
C. geminatum Lundell, 1871 forma - Lake Sonfon (8)
C. hammeri Reinsch, 1867 forma - Njala (2); Kabala (2)
C. humile (Gay) Nordstedt, 1889 forma - Njala (2)
C. javanicum Nordstedt, 1880 - Loma Mnts (7)
C. laeve Rabenhorst, 1868 v. ***leave*** - Njala (2); Bathurst Falls (11)
C. laeve v. ***messikommeri*** Croasdale in Prescott et al., 1981 - Lake Sonfon (8)
= *C. laeve* Rabenhorst, 1868 v. *rotundatum* Messikömmer, 1935
C. laeve v. ***westii*** Krieger et Gerloff, 1969 - Njala (2)
= *C. laeve* Rabenhorst, 1868 v. *septentrionale* Wille in Taylor, 1934
C. loefgrenii Borge, 1918 forma - Njala (2)
C. mansangense West et West, 1907 v. ***africanum*** Fritsch et Rich, 1924 - Loma Mnts (7); Bathurst Falls (11)
C. meneghini Brébisson ex Ralfs, 1848 - Njala (2)
C. minimum West et West, 1895 - Lake Sonfon (8)
C. moniliforme Turpin ex Ralfs, 1848 - Njala (2)
C. nitidulum De Notaris, 1867 - Kania (9)
C. obsoletum (Hantzsch) Reinsch, 1867 - Njala (2); Loma Mnts (7)
C. orthostichum Lundell, 1871 v. ***pumilum*** Lundell, 1871 - Njala (2)
C. polymorphum Nordst., 1870 v. ***africanum*** Bourrelly, 1957 - Lake Sonfon (8)
C. polymorphum v. ***africanum*** Bourrelly, 1957 forma - Njala (2)
C. porrectum Nordstedt, 1870 - York (13)
C. portianum Archer, 1860 v. ***nephroideum*** Wittrock, 1872 - Lake Sonfon (8)
C. pseudamoenum Wille, 1884 v. ***inornatum*** (Joshua) Croasdale in Grönblad et al, 1968 - Njala (2)
C. pseudobroomei Wolle, 1884 - Bathurst Falls (11); York (13)
C. pseudoconnatum Nordstedt, 1870 - Bathurst Falls (11)
C. pseudopyramidatum Lundell, 1871 v. ***pseudopyramidatum*** - Njala (2); Kania (9)
C. pseudopyramidatum v. ***oculatum*** Krieger, 1932 - York (13)
C. pseudoretusum Ducellier, 1918 v. ***africanum*** (Fritsch) Krieger et Gerloff, 1962 - Lake Sonfon (8); Bathurst Falls (11); York (13)
C. punctulatum Bréb., 1856 v. ***subpunctulatum*** (Nordst.) Börgesen, 1894 - Njala (2)
C. pyramidatum Brébisson ex Ralfs, 1948 v. ***pyramidatum*** - Lake Sonfon (8)
C. pyramidatum Brébisson ex Ralfs, 1948 v. ***pyramidatum*** forma - Lake Sonfon (8)
C. pyramidatum v. ***stephani*** (Irenee-Marie) Krieger et Gerloff, 1965 - Loma Mnts (7)
C. quadratum Ralfs, 1848 v. ***africanum*** Fritsch et Stephens, 1921 - Kania (9)
C. quadrum Lundell, 1871 v. ***quadrum*** - Kabala (2)
C. quadrum v. ***minus*** Nordstedt, 1873 - York (13)
C. ralfsii Brébisson ex Ralfs, 1848 v. ***montanum*** Raciborski, 1885 - Loma Mnts (7)
C. regnelli Wille, 1884 v. ***regnelli*** - Lake Sonfon (8)
C. regnelli v. ***minimum*** Eichler et Gutwinski, 1894 - Kania (9)
C. rossii Ricci in Ricci & Alfinito, 1994 - York (13)
C. salisburii Fritsch et Rich, 1937 forma - Lake Sonfon (8)
C. sexangulare Lundell, 1871 v. ***minus*** Roy et Bisset, 1886 - Lake Sonfon (8)
= *C. sexangulare* Lundell, 1871 f. *minima* Nordstedt, 1887
C. subconstrictum Schmidle, 1902 - Lake Sonfon (8)
C. subcostatum Nordstedt, 1876 - Njala (2)
C. subcostatum Nordstedt, 1876 forma - Njala (2)
C. subprotumidum Nordstedt, 1876 - Kania (9)

C. succisum G. S. West, 1992 f. ***jaoi*** Krieger et Gerloff, 1962	- Lake Sonfon (8)
C. tenue Archer, 1868	- Njala (2)
C. venustum (Bréb.) Archer ex Pritchard, 1862	- Lake Sonfon (8)
C. wenmanae Croasdale in Grönblad et al., 1968	- Njala (2); Bathurst Falls (11)
C. westii Bernard, 1908	- Loma Mnts (7)
C. zonatum Lundell, 1871 v. ***subcylindricum*** Grönblad et Scott in Grönblad et al, 1958	- Njala (2)
Cosmarium sp. 1	- Njala (2)
Cosmarium sp. 2	- Njala (2)

Cosmocladium Brébisson, 1856

C. tuberculatum Prescott, 1935	- Lake Sonfon (8); Lake Tibi (10)

Desmidium Agardh ex Ralfs, 1848

D. aequale West et West, 1896 f. ***elliptica*** West et West, 1896	- Njala (2)
D. cfr. ***aptogonum*** Brébisson ex Kützing, 1849 forma	- Njala (2)
D. gracilipes (Nordst.) Lagerheim, 1886	- Guma Dam (12)
D. gracilipes (Nordst.) Lagerheim, 1886 forma	- Njala (2)

Docidium Brébisson ex Ralfs, 1848

D. baculum Brébisson ex Ralfs, 1848	- Lake Sonfon (8)
D. lomaense Alfinito et Mazzoni, 1986	- Loma Mnts (7)

Euastrum Ehrenberg ex Ralfs, 1848

E. abruptum Nordstedt, 1869 v. ***lagoense*** (Nordst.) Krieger, 1937	- River Jong (10)
E. ansatum Ehrenberg ex Ralfs, 1848 v. ***ansatum***	- Lake Sonfon (8)
E. ansatum v. ***dideltiforme*** Ducellier, 1918	- Njala (2)
E. ansatum v. ***javanicum*** (Gutw.) Krieger, 1937	- Lake Sonfon (8)
E. bidentatum Nägeli, 1849 forma	- Njala (2)
E. binale (Turp.) Ehrenberg ex Ralfs, 1848 v. ***cosmarioides*** (West et West) Krieger, 1937 forma 1	- Njala (2)
E. binale v. ***cosmarioides*** (West et West) Krieger, 1937 forma 2	- Njala (2)
E. binale v. ***groenbladii*** (Messik.) Krieger, 1937	- Loma Mnts (7)
E. binale v. ***groenbladii*** (Messik.) Krieger, 1937 forma	- Njala (2)
E. binale v. ***pseudopapilliferum*** Förster, 1963	- Loma Mnts (7)
E. bombayense Brandham, 1967 v. ***gracile*** Brandham, 1967	- River Sewa (10)
E. brasiliense Borge, 1903 v. ***simplicius*** Borge, 1903	- Loma Mnt (7)
E. denticulatum (Kirchner) Gay, 1884 v. ***denticulatum***	- Lake Sonfon (8); River Waanje, River Jong (10), Bathurst Falls (11)
E. denticulatum v. ***quadrifarium*** Krieger, 1937	- Lake Tibi, Lake Mabesi, Lake Mape (10)
E. cfr. ***denticulatum*** (Kirchner) Gay, 1884	- Njala (2); Kabala (2)
E. didelta Ralfs ex Ralfs, 1848 v. ***didelta***	- Lake Sonfon (8); Bathurst Falls (11)
E. didelta v. ***bengalicum*** Lagerheim, 1888	- Lake Tibi, Lake Popei, Lake Mabesi (10)
E. divaricatum Lund., 1871 v. ***uguandanum*** Grönblad in Grönblad et al., 1968	- Njala (2)
E. gemmatum Brébisson ex Ralfs, 1848 v. ***gemmatum***	- Guma Dam (12)
E. gemmatum v. ***tenuius*** Krieger, 1937	- Kania (9)
E. germanicum (Schmidle) Krieger, 1937	- Njala (2)
E. humbertii Bourrelly et Leboime, 1946	- Njala (2)
E. inerme (Ralfs) Lundell, 1871	- Njala (2)
E. ivoirensis Bourrelly, 1961	- Bathurst Falls (11); Guma Dam (12)

E. ivoirensis Bourrelly, 1961 forma - Lake Sonfon (8)
E. luetkemuelleri Ducel., 1918 v. ***carniolicum*** (Lütkem.) Krieger, 1937 - York (13)
E. luetkemuelleri v. ***carniolicum*** (Lütkem.) Krieger, 1937 forma - Njala (2)
E. platycerum Reinsch, 1875 v. ***eximium*** Grönblad, 1958
f. ***clausum*** Grönbl. et Scott in Grönblad et al., 1958 - River Sewa, River Jong (10)
NOTE: this taxon is invalidly published, art. 37 ICBN, according Růžička (1981)
E. pulchellum Brébisson, 1856 v. ***retusum*** West et West, 1905 - Njala (2)
E. pseudosinuosum Förster, 1964 - Kania (8); York (13)
E. serratum Joshua, 1886 v. ***crenulatum*** Hirano, 1967 forma - York (13)
E. sibiricum Boldt, 1885 v. ***exsectum*** (Grönbl.) Krieger, 1937 - Lake Sonfon (9)
E. sinuosum Lenormand 1861 v. ***scrobiculatum*** (Nordst.) Krieger, 1937 - York (13)
E. sinuosum v. ***subjenneri*** West et West, 1902 - Bathurst Falls (11); York (13)
E. spinulosum Delponte, 1876 var. ***aequilobium*** (West et West)
Krieger, 1937 - River Sewa (10)
E. subbinale Messikömmer, 1956 - Kania (9)
E. subhexalobum West et West, 1898 v. ***subhexalobum*** - Lake Sonfon (8)
E. subhexalobum v. ***scrobiculatum*** Grönblad, 1945 - Njala (2)
E. sublobatum Brébisson ex Ralfs, 1848 v. ***incrassatum*** Scott et
Prescott, 1961 - Njala (2)
E. sublobatum Brébisson ex Ralfs, 1848 variety? - Njala (2)
E. triggiberum West et West, 1895 - Lake Tibi, Lake Popei (10)
E. truncatiforme G.S. West, 1907 v. ***africanum*** Bourrelly, 1957 - York (13)
E. truncatiforme v. ***africanum*** Bourrelly, 1957 forma - Lake Sonfon (8)
E. truncatum Joshua, 1886 v. ***trifolium*** (Cohn) Krieger, 1937 forma - York (13)
E. validum West et West, 1896 v. ***validum*** - Njala (2)
E. validum West et West, 1896 v. ***validum*** forma - Njala (2)
E. validum v. ***subvalidum*** (Behre) Bourrelly, 1961 forma - Njala (2)
NOTE: this taxon is invalidly published, art. 33 ICBN, according Růžička (1981)
Euastrum sp. - Njala (2)

Gonatozygon de Bary, 1856

G. aculeatum Hastings, 1892 - Lake Mape, River Waanje, River Jong (10)
G. kinahani (Arch.) Rabenhorst, 1868 - Lake Sonfon (8); Lake Mape, Lake Tibi (10)
G. monotaenium de Bary, 1856 - Kabala (2); River Sewa (10)

Groenbladia Teiling, 1952

G. fennica (Grönbl.) Teiling, 1952 - Njala (2)
G. inflata Scott et Grönblad, 1957 - Njala (2)
G. neglecta (Racib.) Teiling, 1952
cfr. v. ***elongata*** Scott et Grönblad, 1957 - Njala (2)

Haplotaenium Bando, 1988

H. minutum (Ralfs) Bando, 1988 v. ***gracile*** (Wille) Bando, 1988 - Bathurst Falls (11); York (13)
= *Pleurotaenium minutum* (Ralfs) Delp., 1877 v. *gracile* (Wille) Krieger, 1932

Hyalotheca Ehrenberg ex Ralfs, 1848

H. dissiliens (Sm.) Bréb. ex Ralfs, 1848 v. ***tatrica*** Racib., 1885 - Njala (2); York (13)

Micrasterias Agardh ex Ralfs, 1848

M. ambadiensis (Grönbl. et Scott) Thomasson, 1960	- River Waanje, River Jong (10)
M. americana Ehrenberg ex Ralfs, 1848 v. ***americana*** forma	- Njala (2)
M. americana v. ***bimamillata*** Bourrelly et Couté in Couté & Rousselin, 1975 forma	- River Jong (10)
M. americana v. ***hybrida*** Woodhead et Tweed, 1959 NOTE: this taxon has been validated by Gerrath & Denny (1998) designating as neotype their fig. 49 (Gerrath & Denny, *loc. cit.*, pag. 47)	- Lake Sonfon (8); River Jong (10)
M. crux-melitensis (Ehr.) Hassall ex Ralfs, 1848	- Lake Sonfon (8); River Jong (10).
M. decemdentata (Näg.) Archer, 1861	- Lake Sonfon (8)
M. echinata Brandham, 1967	- Kenema (1); River Jong, River Sewa (10); York (13)
M. foliacea Bailey ex Ralfs, 1848	- River Jong, Lake Gambia, Lake Popei, River Sewa, Lake Tibi (10)
M. furcata Ralfs, 1848 = *M. radiata* Hassall, 1845	- Njala (2); River Jong (10)
M. jenneri Ralfs, 1848 v. ***simplex*** W. West, 1890 forma	- River Jong (10)
M. mahabuleshwarensis Hobson, 1863 v. ***comperei*** Couté et Rousselin, 1975	- River Waanje, River Jong, Lake Popei, River Sewa, (10)
M. mahabuleshwarensis v. ***semireducta*** Scott et Croasdale in Grönblad et al., 1968	- Njala (2)
M. pinnatifida Kütz. ex Ralfs, 1848 v. ***polymorpha*** Bourrelly in Bourrelly & Manguin, 1949	- River Jong (10)
M. radians Turner, 1892	- River Waanje, River Jong (10)
M. thomasiana Archer, 1892 v. ***notata*** (Nordst.) Grönblad, 1920	- River Jong (10)
M. tropica Nordstedt, 1870 v. ***elongata*** Schmidle, 1898	- Lake Sonfon (8)
M. truncata (Corda) Brébisson ex Ralfs, 1848 v. ***truncata***	- Njala (2)
M. truncata v. ***crenata*** (Bréb.) Reinsch, 1867	- Loma Mnts (7)

Penium Brébisson ex Ralfs 1848 em. Kouwets et Coesel, 1984

P. cylindraceum Förster, 1965 v. ***cylindraceum*** f. ***majus*** Croasdale in Grönblad et al., 1968	- Njala (2)
P. cylindrus (Ehr.) Brébisson ex Ralfs, 1848	- Bathurst Falls (11); Guma Dam (12); York (13)
P. margaritaceum (Ehr.) Brèbisson ex Ralfs, 1848	- Njala (2)
P. multicostatum Scott et Grönblad, 1957	- Kania (9)
P. polymorphum (Perty) Perty, 1852	- Njala (2)

Pleurotaenium Nägeli, 1849

P. coronatum (Bréb.) Rabenhorst, 1868 v. ***fluctuatum*** W. West, 1892	- Guma Dam (12)
P. ehrenbergii (Bréb.) de Bary, 1858 v. ***ehrenbergii***	- Njala (2); Loma Mnts (7); Lake Popei, River Jong (10); Bathurst Falls (11); Guma Dam (12)
P. ehrenbergii v. ***curtum*** Krieger, 1937	- Njala (2)
P. ehrenbergii v. ***undulatum*** Schaarschmidt, 1883	- Njala (2); York (13)
P. moniliferum West et West, 1895	- Lake Sonfon (8)
P. nodulosum (Bréb.) de Bary, 1858	- York (13)
P. ovatum Nordstedt, 1877	- Njala (2); River Jong (10)
P. simplicissimum Grönblad, 1920	- Lake Sonfon (8)
P. subcoronulatum (Turn.) West et West, 1895 v. ***subcoronulatum***	- Njala (2); Lake Mape, Lake Popei, River Sewa, Lake Tibi (10)

P. subcoronulatum (Turn.) West et West, 1895 v. ***subcoronulatum*** forma	- Njala (2); Kabala (2)
P. subcoronulatum v. ***africanum*** (Schmidle) Krieger, 1937	- River Sewa (10)
P. subcoronulatum v. ***detum*** West et West, 1896	- Njala (2)
P. subcoronulatum v. ***detum*** West et West, 1896 forma	- Njala (2)
P. trabecula Nägeli, 1849 v. ***trabecula***	- Lake Sonfon (7); River Waanje (10)
P. trabecula v. ***crassum*** Wittrock, 1872	- York (13)
P. truncatum (Bréb.) Nägeli, 1849	- York (13)

Staurastrum Meyen em. Ralfs, 1848

S. avicula Brébisson ex Ralfs, 1848	- Loma Mnts (7)
S. brachiatum Ralfs, 1848	- Lake Sonfon (8)
S. brebissonii Archer ex Pritchard, 1861	- Lake Sonfon (8)
S. cerastes Lundell, 1871 v. ***pulchrum*** Scott et Grönblad, 1957 forma	- Njala (2)
S. ***contectum*** Turner, 1892 f. ***concavum*** Scott et Croasdale in Grönblad et al., 1968	- Njala (2)
S. dilatatum (Ehr.) Ralfs, 1848 v. ***dilatatum***	- Njala (2); Kabala (2)
S. dilatatum v. ***hibernicum*** West et West, 1912	- Njala (2)
S. disputatum West et West, 1912 v. ***sinense*** (Lütkm.) West et West, 1912	- Njala (2)
S. distentum Wolle, 1892 forma	- Lake Sonfon (8)
S. forficulatum Lundell, 1871 v. ***minus*** (Fritch et Rich) Grönblad et Scott in Grönblad et al., 1958 forma	- Njala (2)
S. furcatum (Ehr.) Brébisson, 1856 v. ***furcatum***	- Bathurst Falls (11); Guma Dam (12)
S. furcatum v. ***asymmetricum*** Grönblad et Scott in Grönblad et al., 1958	- Njala (2)
S. gladiosum Turner, 1885	- Njala (2); Kabala (2); Lake Sonfon (8)
S. hystrix Ralfs, 1848 v. ***granulatum*** Ricci in Ricci et al., 1990	- Guma Dam (12)
S. inconspicuum Nordstedt, 1873	- Lake Sonfon (8)
S. leptopus Krieger, 1932 forma	- Njala (2)
S. longibrachiatum (Borge) Gutwinski, 1902 v. ***africanum*** Bourrelly, 1961	- Njala (2)
S. margaritaceum (Ehr.) Meneghini ex Ralfs, 1848 forma	- Kabala (2)
S. manfeldtii Delponte, 1876 v. ***africanum*** Hodgett, 1926	- York (13)
S. micron West et West, 1896	- Kabala (2)
S. orbiculare (Ehr.) Ralfs, 1848 v. ***depressum*** Roy et Bisset, 1886	- Njala (2); Lake Sonfon (8)
S. pelagicum West et West, 1902	- Guma Dam (12)
S. pinnatum Turner, 1892 v. ***hydra*** Krieger, 1932	- Njala (2)
S. pseudotetracerum (Nordst.) West et West, 1895	- Lake Sonfon (8); York (13)
S. quadrangulare (Bréb.) Ralfs, 1848	- Njala (2)
S. quadrangulare (Bréb.) Ralfs, 1848 forma	- Kabala (2)
S. quadricornutum Roy et Bisset, 1886	- Lake Sonfon (8)
S. setigerum Cleve, 1864 **v. *pectinatum*** West et West, 1896 f. ***paucispiniferum*** Croasdale in Grönblad et al., 1968	- Njala (2)
S. setigerum v. ***pectinatum*** West et West, 1896 forma	- Njala (2)
S. spiculiferum Borge, 1918 v. ***glabrum*** Gerrath et Denny, 1988	- Lake Sonfon (8)
S. subindentatum West et West, 1907 v. ***ornatum*** Bourrelly, 1961 forma	- Njala (2)
S. teliferum Ralfs, 1848 v. ***ordinatum*** Börgesen, 1894	- Guma Dam (12)
S. tetracerum Ralfs, 1848	- Njala (2); Kabala (2); Kania (9); Bathurst Falls (11)
S. wildemanii Gutwinski, 1902 v. ***wildemanii*** f. ***quadrispinum*** Thomasson, 1966	- Njala (2)
S. wildemanii v. ***horizontale*** Scott et Prescott, 1956	- Njala (2)
S. wildemanii v. ***majus*** (West et West) Scott et Prescott, 1956	- Njala (2)

Staurodesmus Teiling, 1948

S. cuspidatus (Bréb.) Teiling, 1967 = *Staurastrum cuspidatum* (Bréb.) Ralfs, 1848	- Njala (2)
S. glaber (Ehr.) Teiling, 1967 = *Staurastrum glabrum* (Ehr.) Ralfs, 1848	- Njala (2)
S. incus (Bréb.) Teiling, 1967 forma1 = *Arthrodesmus incus* (Bréb.) Ralfs, 1848 forma 1	- Njala (2)
S. incus (Bréb.) Teiling, 1967 forma 2 = *Arthrodesmus incus* (Bréb.) Ralfs, 1848 forma 2	- Njala (2)
S. incus (Bréb.) Teiling, 1967 forma 3 = *Arthrodesmus incus* (Bréb.) Ralfs, 1848 forma 3	- Kabala (2)
S. omearii (Arch.) Teiling, 1948 forma = *Staurastrum o'mearii* Archer, 1858 forma	- Njala (2); Kabala (2)
S. patens (Nordstedt) Croasdale, 1957 v. ***patens*** f. ***inflatus*** (W. West) Teiling, 1967	- Lake Sonfon (8)

Teilingia Bourrelly, 1964

T. excavata (Ralfs) Bourrelly, 1964 = *Sphaerozosma excavatum* Ralfs, 1848	- Njala (2)
T. granulata (Roy et Bisset) Bourrelly, 1964 = *Sphaerozosma granulatum* Roy et Bisset, 1886	- Njala (2); Lake Sonfon (8)

Tetmemorus Ralfs ex Ralfs, 1848

T. granulatus (Bréb.) Ralfs ex Ralfs, 1848	- Loma Mnts (7)
T. laevis (Kütz.) ex Ralfs, 1848 v. ***laevis***	- Kania (8): Guma Dam (12); York (13)
T. laevis v. ***borgei*** Förster, 1965	- Kania (9)

Xanthidium Ehrenberg ex Ralfs, 1848

X. octocorne (Ehr.) Ralfs, 1848 = *Arthrodesmus octocornis* (Ehr.) Ralfs, 1848	- Njala (2)
X. urniforme (West et West) Scott et Croasdale in Grönblad et al., 1968	- Njala (2); Guma Dam (12); York (13)

AKNOWLEDGEMENTS

The author wishes to thank prof. Walter Rossi (Department of Environmental Sciences, University of L'Aquila) for providing the photos of some of the sampling sites.

REFERENCES

Alfinito S. & Mazzoni A., 1986. Some desmids (Chlorophyta) from Sierra Leone. Quaderni Accademia Nazionale dei Lincei, 260: 97-104.

Alfinito S., Fumanti B. & Ricci S., 1989. Freshwater algae from Kania (Sierra Leone, West Tropical Africa). Rivista di Idrobiologia, 28: 167-178.

Alfinito S., Fumanti B. & Ricci S., 1990. Freshwater algae from Sierra Leone: desmids from Bathurst Falls. Quaderni Accademia Nazionale dei Lincei, 265: 15-26.

Alfinito S., Fumanti B. & Ricci S., 1994. Diatoms from York, Sierra Leone (West Africa). Quaderni Accademia Nazionale dei Lincei, 267: 65-79.

Anagnostidis K. & Komárek J., 1989. Modern approach to the classification system of Cyanophytes. 4- Nostocales. Algological Studies, 56: 247-345.

Anagnostidis K. & Komárek J., 1990. Modern approach to the classification system of Cyanophytes. 5- Stigonematales. Algological Studies, 59: 1-73.

Brandham P.E., 1967. Three new desmid taxa from West Africa, including two asymmetrical forms. British Phycological Bullettin, 3: 189-193.

Carter J. R. & Denny P., 1982. Freshwater algae of Sierra Leone IV. Bacillariophyceae; Part (i) diatoms from the river Jong (Taia) at Njala. Beiheft zur Nova Hedwigia, 73: 281-331.

Carter J. R. & Denny P., 1987. Freshwater algae of Sierra Leone IV. Bacillariophyceae; Part (ii) diatoms from the coastal region of the southern province. Nova Hedwigia, 44: 229-275.

Carter J. R. & Denny P., 1992. Freshwater algae of Sierra Leone IV. Bacillariophyceae; Part (iii) diatoms from the lake Sonfon region and from Lake Popei. Nova Hedwigia, 54: 159-211.

Coesel P. F. M. & Meester K. J., 2007. Desmids of the Lowlands. KNNV Publishing. Zeist, The Netherlands, 351 pp.

Croasdale H., Bicudo C. E. & Prescott G. W., 1983. A synopsis of North American Desmids. Part II. Desmidiaceae: Placodermae, sect. 5. The filamentous genera. University Nebraska Press, Lincoln and London. 117 pp.

Ettl H., 1978. Xanthophyceae 1 Teil. In: Ettl H., Gerloff J., Heynig H. & Mollenhauer D., Süsswasserflora von Mitteleuropa, Bd 3. G. Fischer Verl., Jena, Stuttgart, 530 pp.

Ettl H., 1983. Chlorophyta I. Phytomonadina. In: Ettl H., Gerloff J., Heynig H. & Mollenhauer D., Süsswasserflora von Mitteleuropa, Bd 9. G. Fischer Verl., Jena, Stuttgart, 807 pp.

Ettl H. & Gärtner G., 1988. Chlorophyta II. Tetrasporales, Chlorococcales, Gloeodendrales. In: Ettl H., Gerloff J., Heynig H. & Mollenhauer D., Süsswasserflora von Mitteleuropa, Bd 10. G. Fischer Verl., Jena, Stuttgart, 436 pp.

Förster K., 1982. Conjugatophyceae, Zygnematales und Desmidiales (excl. Zygnemataceae). In: Elster H. & Ohle W., Die Binnengewässer, Bd 16/8. E. Schweizerbart'sche Verl. Stuttgart, 543 pp.

Fumanti B., 1994. Freshwater algae from Sierra Leone: diatoms from Bathurst Falls (Western Area). Quaderni Accademia Nazionale dei Lincei, 267: 51-64.

Fumanti B., Ricci S. & Alfinito S., 1990. Freshwater algae from Sierra Leone: Diatoms from Guma Valley. Quaderni Accademia Nazionale dei Lincei, 265: 27-47.

Gerrath J. F. & Denny P., 1979. Freshwater Algae of Sierra Leone I. Euglenophyta. Nova Hedwigia, 31: 525-565.

Gerrath J. F. & Denny P., 1980. Freshwater Algae of Sierra Leone II: Chlorophyta, exclusive of Desmidiales. Nova Hedwigia, 33: 445-463.

Gerrath J. F. & Denny P., 1980a. Freshwater Algae of Sierra Leone III: Cyanophyta, Chrysophyta, Xanthophyta, Chloromonadophyta, Cryptophyta, Dinophyta. Nova Hedwigia, 33: 933-947.

Gerrath J. F. & Denny P., 1988. Freshwater Algae of Sierra Leone V. Desmids from the Lake Sonfon region. Nova Hedwigia, 47: 39-58.

Gerrath J. F. & Denny P., 1989. Freshwater Algae of Sierra Leone VI. Desmids (*Gonatozygon* to *Pleurotaenium*) from the Southern Province. Nova Hedwigia, 48: 167-186.

Grönblad R., Scott A. M. & Croasdale H., 1968. Desmids from Sierra Leone, Tropical West Africa. Acta Botanica Fennica, 78: 1-41.

Hoek C. van den, Mann D. G. & Jahns H. M., 1995. Algae. An introduction to phycology. Cambridge University Press, Cambridge, 623 pp.

Huber-Pestalozzi G., 1950. Das Phytoplankton des Süsswasser. 3 Teil. Cryptophyceae, Chloromonadinen, Peridineen. In: Thienemann A., Die Binnengewässer, Bd 16/3. E. Schweizerbart'sche Verl. Stuttgart, 310 pp.

Huber-Pestalozzi G., 1955. Das Phytoplankton des Süsswasser. 4 Teil. Euglenophyceae. In: Thienemann A., Die Binnengewässer, Bd 16/4. E. Schweizerbart'sche Verl. Stuttgart, 606 pp. + 114 plates.

Komárek J. & Anagnostidis K., 1999. Cyanoprokaryota 1 Teil: Chroococcales. In: Ettl H., Gerloff J., Heynig H. & Mollenhauer D., Süsswasserflora von Mitteleuropa, Bd 19/1. G. Fischer Verl., Jena, Stuttgart, 548 pp.

Komárek J. & Anagnostidis K., 2005. Cyanoprokaryota 2 Teil: Oscillatoriales. In: Ettl H., Gerloff J., Heynig H. & Mollenhauer D., Süsswasserflora von Mitteleuropa, Bd 19/2. G. Fischer Verl., Jena, Stuttgart, 759 pp.

Komárek J. & Fott B., 1983. Das Phytoplankton des Süsswasser. 7 Teil. Chlorophyceae, Chlorococcales. In: Thienemann A., Die Binnengewässer, Bd 16. E. Schweizerbart'sche Verl. Stuttgart, 1044 pp.

Komárek J. & Hauer T., 2011. Cyano DB. cz. On-line database of cyanobacterial genera. World-wide electronic publication, University of South Bohemia & Institute of Botany AS CR, http://www.cyanodb.cz

Mazzoni A., 1986. Freshwater diatoms from Dankale River (Sierra Leone). Quaderni Accademia Nazionale dei Lincei, 260: 105-119.

Mölder K., 1962. Diatomeen aus den Gebirgen Sula und Kangari in Sierra Leone, Westafrika. Bulletin de la Commission Géologique de Finlande, 198: 7-48.

Mrozińska T., 1985. Chlorophyta VI. Oedogoniophyceae: Oedogoniales. In: Ettl H., Gerloff J., Heynig H. & Mollenhauer D., Süsswasserflora von Mitteleuropa, Bd 14. G. Fischer Verl., Jena, Stuttgart, 624 pp.

O'Meara E., 1876. Diatomaceous forms from Rockett River, Sierra Leone. Proceedings of the Societies. Dublin Microscopical Club, 20th april, 1876. Quarterly Journal of the Microscopical Society, 16: 414.

Popovský J. & Pfiester L. A., 1990. Dinophyceae. In: Ettl H., Gerloff J., Heynig H. & Mollenhauer D., Süsswasserflora von Mitteleuropa, Bd 6. G. Fischer Verl., Jena, Stuttgart, 272 pp.

Prescott G. W., Bicudo C. E. & Vinyard W. C., 1982. A synopsis of North American Desmids. Part II. Desmidiaceae: Placodermae, sect. 4. University Nebraska Press, Lincoln and London, 700 pp.

Prescott G. W., Croasdale H. & Vinyard W. C., 1972. North American Flora. Ser. II. Part 6. New York Botanical Garden Ed., New York, 84 pp.

Prescott G. W., Croasdale H. & Vinyard W. C., 1975. A synopsis of North American Desmids. Part II. Desmidiaceae: Placodermae, sect. 1. University Nebraska Press, Lincoln, 275 pp.

Prescott G. W., Croasdale H. & Vinyard W. C., 1977. A synopsis of North American Desmids. Part II. Desmidiaceae: Placodermae, sect. 2. University Nebraska Press, Lincoln, 413 pp.

Prescott G. W., Croasdale H., Vinyard W. C. & Bicudo C. E, 1981. A synopsis of North American Desmids. Part II. Desmidiaceae: Placodermae, sect. 3. University Nebraska Press, Lincoln, 720 pp.

Printz H., 1964. Die Chaetphoralen der Binnengewässer. Eine systematische Übersicht. Hydrobiologia, 24: 1-376.

Ricci S. & Alfinito S., 1994. The desmid flora of York, Sierra Leone (West Africa). Quaderni Accademia Nazionale dei Lincei, 267: 81-96

Ricci S., Alfinito S. & Fumanti B., 1990. Desmids from Guma Valley (Sierra Leone, West Africa). Hydrobiologia, 208: 235-247

Růžička J., 1977. Die Desmidiaceen Mitteleuropas, Bd 1/1. E. Schweizerbart'sche Verl. Stuttgart, 292 pp. + 44 plates.

Růžička J., 1981. Die Desmidiaceen Mitteleuropas, Bd 1/2. E. Schweizerbart'sche Verl. Stuttgart, pp. 292-736 + plates 45-117.

Starmach K., 1985. Chrysophyceae und Haptophyceae. In: Ettl H., Gerloff J., Heynig H. & Mollenhauer D., Süsswasserflora von Mitteleuropa, Bd 1. G. Fischer Verl., Jena, Stuttgart, 515 pp.

Whitton B. A., 1968. Blue-Green Algae from Sierra Leone. Nova Hedwigia, 15: 203-209.

Woodhead N. & Tweed R. D., 1958. A check list of tropical West African Algae. Hydrobiologia, 11: 299-395.

Woodhead N. & Tweed R. D., 1959. Freswater algae of Sierra Leone. I. New and unusual algae from the Sula Hill. Hydrobiologia, 12: 181-225.

Woodhead N. & Tweed R. D., 1960. Freswater algae of Sierra Leone. 3. The algae of Rokupr and great Scarcies River. Revue Algologique, 5: 116-150.

Biodiversity Journal, 2011, 2 (3): 145-148

Crocidura sicula Miller, 1900 (Mammalia, Soricidae): a possible new record from Comino island (Maltese Islands)

Gaetano Aloise[1], Alfred E. Baldacchino[2] & Giovanni Amori[3]

[1] Museo di Storia Naturale della Calabria e Orto Botanico, University of Calabria, Via P. Bucci, s.n., I-87036 Rende, Italy. [2]Kestrel in Melita House, Notary Zarb Street, Attard, Malta. [3]CNR - Institute of Ecosystem Studies, c/o Department of Biology and Biotechnology "C. Darwin", Sapienza University – Zoology, Viale dell'Università 32, I-00185 Rome – Italy

ABSTRACT The presence of *Crocidura sicula* Miller, 1900 is reported for the first time from the Comino island. Two specimens were obtained from the analysis of Long-eared Owl *Asio otus* (Linnaeus, 1758) pellets.

KEY WORDS *Crocidura sicula;* Comino; Maltese islands.

Received 02.09.2011; accepted 16.09.2011; printed 30.09.2011

INTRODUCTION

The Sicilian shrew *Crocidura sicula* Miller, 1900 is a Mediterranean species, endemic to the Siculo-Maltese archipelago. This species is widely distributed in the island of Sicily and it also occurs in the neighbouring Egadi islands (Marettimo, Favignana and Levanzo) and in Ustica island. In the Maltese archipelago this species is recorded only from the island of Gozo. Though fossilized bones have been discovered on the island of Malta, confirming its past presence, it seems that it has now become extinct from the main island for unknown reasons (Hutterer, 2005).

Taxonomy and distribution of shrews of Maltese islands have been debated for a long time. In the past *Suncus etruscus* (Savi, 1822) was known as the only species occurring in Malta and Gozo, while *Crocidura suaveolens* (Pallas, 1811) and *C. russula* (Hermann, 1780) were recorded only in Gozo. On the basis of current knowledge *S. etruscus* occurs in Malta and *Crocidura* in Gozo (Schembri & Schembri, 1979). During the last decades a number of authors agreed to classify the Gozo populations as *C. suaveolens* (Schembri & Schembri, 1979; Hutterer, 1991). During the same time, the *Crocidura* spp. populations of Sicily were debated, often controversially, on their taxonomic status and also on the number of species occurring in the island (Sarà, 2008). Currently all the populations occurring in the Siculo-Maltese archipelago belong to the endemic species *C. sicula* (Vogel, 1988; Vogel et al., 1990; Contoli et al., 1989; Sarà et al., 1990).

Hutterer (1991) identified a distinct taxon for Gozo: *C. sicula calypso*, which is different from those of Egadi Islands (*C. sicula aegatensis* Hutterer, 1991) and from those of Sicily (*C. sicula sicula*). Such subspecific subdivision has not been recognized by Sarà (1995) and Sarà & Vitturi (1996).

RESULTS

Some pellets (n = 3) and other pellet fragments have been collected during April 2005 on the small island of Comino from beneath the nest of a Long-eared Owl *Asio otus* (Linnaeus, 1758), (J. Azzopardi and M. Sammut leg.), although the nest was occupied and used the previous year (Baldacchino & Azzopardi, 2007).

The species identified from the analysis of this material were *Oryctolagus cuniculus* (Linnaeus, 1758) (n = 2), *Mus musculus* Linnaeus, 1758 (n =3) and *Rattus rattus* (Linnaeus, 1758) (n =1), already known from the island, and also

two specimens of *C. sicula*. The record of *C. sicula* is the first record of the occurrence of this species from Comino.

Table 1 gives some cranial measurements of two specimens from Comino. The two specimens from Comino showed values similar to those reported in Sarà (2008) from Gozo.

DISCUSSION AND CONCLUSIONS

The Maltese islands are located in the centre of the Mediterranean, just 96 km south of Sicily, 290 km from North Africa, 1836 km from Gibraltar, and 1519 km from Alexandria Egypt, making them Europe's southernmost outpost (Schembri, P.J., 1993). The Maltese archipelago is made up of three major inhabited islands: Malta, the largest; Gozo (Għawdex) and Comino, the smallest (Kemmuna). Besides, around these, there are other scattered uninhabited islets and rocks. The total surface area of the Maltese islands is 316 km^2. This geographical location of the Maltese islands gives them unique ecological characteristics (Fig. 1).

Comino has a smaller islet adjacent to it: Cominotto (Kemmunett). The surface area of Comino is 2.8 km^2, while that of Cominotto is only 9.9 ha. These two islands are entirely made up of upper coralline limestone, one of the five sedimentary layers which form the archipelago. This layer reaches its maximum thickness at Comino.

Like most of the northern and north-eastern coastline of the island of Malta and that of the east coast of Gozo, the north and the south facing

	ZW	PL	M_1-M_3	E	COH
Comino, specimen 1	5.82	7.37	3.65	0.92	4.27
Comino, specimen 2	--	7.23	3.68	--	4.26
Gozo (Sarà, 2008)	5.71 ± 0.11	7.36 ± 0.24	3.73 ± 0.12	0.90 ± 0.05	4.36 ± 0.11

Table 1. Some cranial measurements expressed in cm of *Crocidura sicula* from the Maltese islands.
ZW = zygomatic width, PL = palate length, M_1-M_3 = mandibular molar row length, E = width of articular condylum, COH = Coronoid height.

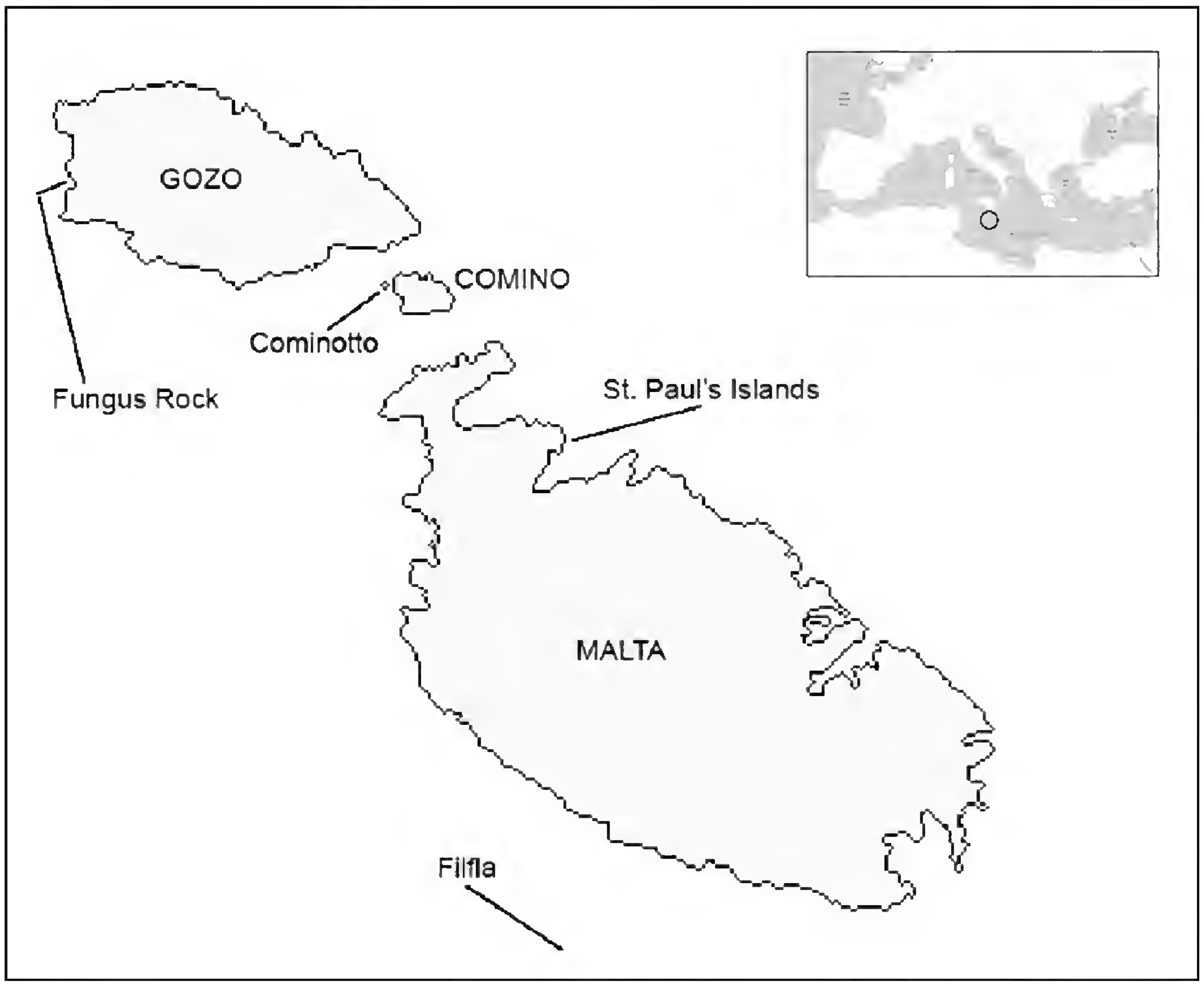


Figure 1. Map of Maltese Archipelago (latitude 35º 48' 28" – 36º 05' 00" North, longitude 14º 11' 04" - 14º 34' 37" East). Surface area of each island: Malta 245.7 km^2, Gozo 67.1 km^2, Comino 2.8 km^2, St. Paul's Islands 10.1 ha, Cominotto 9.9 ha, Filfla 2.0 ha, Fungus Rock 0.7 ha, Maltese islands 316 km^2.

coasts of Comino are gently sloping rock. About a century ago, there were approximately 100 inhabitants cultivating small-scale scattered patches, even on the smaller island of Cominotto. Today there are only two inhabitants living on Comino, but there is also a hotel which is very active during the peak touristic season, and a pig farm which is slowly being phased out.

The vegetation of the island of Comino consists predominantly of coastal steppes and garigue. The latter is the most common, characterized by such species as *Thymbra capitata* (L.) Cavanilles, *Anthyllis hermanniae* L., *Teucrium fructicans* L., and the endemic *Euphorbia melitens* Parlatore. Despite the smallness of the island, in one of the small bays on Comino, there is a sand dune which has been almost obliterated by mismanagement, including a very degraded saline marshland. There are also two very small tree reserves, one at the area known as Il-Ħażina which is c. 5,000 m^2, and the other at Il-Qala ta' Santa Marija c. 11,000 m^2 (Ministry for the Environment, 1999).

The terrestrial mammals occurring in the Maltese islands, and also recorded from Comino are: *Rattus norvegicus* (Berkenhout, 1769), *R. rattus*, *M. musculus, Apodemus sylvaticus* (Linnaeus, 1758), *O. cuniculus* and the bat *Pipistrellus kuhlii* (Kuhl, 1817) though not excluding other migratory bat species.

Terrestrial mammals occurring in the Maltese islands but not yet recorded from Comino are: *Atelerix algirus fallax* (Dobson, 1882), *C. sicula*, *S. etruscus* and Chiroptera which are not considered to be migratory such as *Rhinolophus hipposideros minimus* (Bechstein, 1800), *R. ferrumequinum* (Schreber, 1774), *Myotis blythi punicus* (Tomes, 1857), *Plecotus austriacus* (J.B. Fischer, 1829) and *Pipistrellus pygmaeus* (Leach, 1825). The *Mustela nivalis* (Linnaeus, 1766) is not recorded on Comino either (Baldacchino & Schembri, 2002).

Comino is also rich in endemics or subendemics of both flora and fauna. Amongst these is the subendemic (Malta, Comino and Lampedusa) flora *Daucus lopadusanus* Tineo, the Pelago-Maltese endemic *Linaria pseudolaxiflora* Lojac. in Lojac., a still undescribed *Limonium* Miller, 1754 species, the rare *Darniella melitensis* (Botschantzev) Brullo, two Hybleo-Maltese endemics: *Senecio pygmaeus* DC. and the grass *Desmazeria pignattii* Brullo & Pavone and the last population of *Althea hirsuta* L. Furthermore, Comino supports a population of two species of land snails endemic to the Maltese islands, namely *Trochoidea spratti perplanata* Pilsbry 1893 and *Trochoidea schembrii* (L. Pfeiffer, 1846). The Maltese Wall Lizard *Podarcis filfolensis maltensis* Mertens, 1921, is also recorded on Comino (Ministry for the Environment, 1999).

Because of its ecological importance, Comino is a legally protected Bird Sanctuary, a Special Area of Conservation, and an EU Natura 2000 site.

The size of Comino (2.8 km^2), is smaller than the territory of *Asio otus* in non-insular habitat (Galeotti et al., 1997; Henrioux, 2000), but the hunting area of the Long-eared Owl can vary substantially depending on food supply. Birds with young can hunt up to 2.5 km from nest. However, when food is abundant, territory can be as small as 50 to 100 ha (Oxford CD-Rom, 1998).

Thus the short distance from the island of Gozo (approximately 840 meters) does not exclude the possibility that *C. sicula* were preyed upon in the latter island. The easy availability of prey on Comino could reduce the territory of *A. otus* (Henrioux, 2000). During the nesting season these owls use the territory in the vicinity of the nest (Craig et al., 1988). The abundance of prey, even of large mammals like rabbit *O. cuniculus*, and rats *M. musculus* and *R. rattus* on Comino, species identified from pellets collected from the immediate surroundings of the nest, could support the hypothesis that the Sicilian Shrew (*C. sicula*) has been caught on the island itself.

Further investigations on the presence and abundance of the population of *C. sicula* on Comino island are required also for the conservation of the species in the Maltese Archipelago.

REFERENCES

Baldacchino A.E. & Azzopardi J., 2007. L-Għasafar li jbejtu fl-ambjent naturali tal-gżejjer Maltin. Malta University Publishers Ltd., Msida, Malta.

Baldacchino A.E. & Schembri P.J., 2002. Amfibji, rettili u mammiferi tal-gżejjer Maltin. Sensiela Kullana Kulturali, Nru. 39. Pubblikazzjonijiet Indipendenza: Pietà, Malta.

Contoli L., Benincasa-Stagni B. & Marenzi A.R., 1989. Morfometria e morfologia di *Crocidura* Wagler 1832 (Mammalia, Soricidae) in Italia, Sardegna e Sicilia, con

il metodo dei descrittori di Fourier: primi dati. Hystrix (n.s.), 1: 113-129.

Craig E.H., Craig T.H. & Powers L.R. 1988. Activity patterns and home-range use of nesting long-eared owls. The Wilson Bulletin, 100: 204-213.

Galeotti P., Tavecchia G. & Bonetti A., 1997. Home-range and habitat use of Long-eared owls in open farmland (Po Plain, Northern Italy), in relation to prey availability. Journal of Wildlife Research, 2: 137-145.

Henrioux F., 2000. Home range and habitat use by the Long-Eared Owl in northwestern Switzerland. Journal of Raptor Research, 34: 93-101.

Hutterer R., 1991. Variation and evolution of the Sicilian shrew: Taxonomic conclusions and description of a possibly related species from the Pleistocene of Morocco (Mammalia: Soricidae). Bonner zoologische Beiträge, 42: 241-251.

Hutterer R., 2005. Order Soricomorpha. In: Wilson D.E. & Reeder D.A.M.. Mammal Species of the World. A taxonomic and geographic reference (third edition). Johns Hopkins University Press. Vol. 1, 220-311.

Oxford CD-Rom, 1998. Cramp's The Complete Birds of the Western Palearctic. Oxford University Press.

Sarà M., 1995. The Sicilian (*Crocidura sicula*) and the Canary (*C. canariensis*) shrew (Mammalia, Soricidae): peripheral isolate formation and geographic variation. Bollettino di Zoologia, 62: 173-182.

Sarà M., 2008. *Crocidura sicula* Miller, 1900. In: Amori G., Contoli L., Nappi A., Fauna d'Italia II. Mammalia: Erinaceomorpha, Soricomorpha, Rodentia, Lagomorpha. Calderini ed., Bologna, 210-218.

Sarà M. & Vitturi R., 1996. *Crocidura* (Mammalia, Soricidae) populations from the Sicilian-Maltese insular area. Hystrix, 8: 121-133.

Sarà M., Lo Valvo M. & Zanca L., 1990. Insular variation in central Mediterranean *Crocidura* Wagler, 1832 (Mammalia, Soricidae). Bollettino di Zoologia, 57: 283-293.

Schembri P.J., 1993. Physical geography and ecology of the Maltee Islands: a brief overview. Options Méditerranéennes, Sér. B/n°7 – Malta: Food, Agrilculture, Fisheries and The Environment: 27-39.

Schembri P.J. & Schembri S.P., 1979. On the occurrence of *Crocidura suaveolens* Pallas (Mammalia, Insectivora) in the Maltese Islands with notes on other Maltese shrews. Central Mediterranean Naturalist, 1: 18-21.

Ministry for the Environment, 1999. State of the environment report for Malta 1998. Floriana, Malta: Environment Protection Department, 448 pp.

Vogel P., 1988. Taxonomical and biogeographical problems in Mediterranean shrews of the genus *Crocidura* (Mammalia, Insectivora) with reference to a new karyotype from Sicily (Italy). Société Vaudoise des Sciences Naturelles. Bulletin., 79 (1): 39-48.

Vogel P., Schembri P.J., Borg M. & Sultana J., 1990. The shrew (*Crocidura* sp.) of Gozo, a probable survivor of the Pleistocene fauna of Mediterranean islands. Zeitschrift für Säugetierkunde, 55: 357-359.

Biodiversity Journal, 2011, 2 (3): 149-150

Notes on the distribution of *Castnia invaria penelope* Schaufuss, 1870 (Lepidoptera, Castniidae)

Roberto Vinciguerra

Via XX settembre, 64 - 90141 Palermo, Italy; e-mail: rob.vinciguerra@tiscali.it

ABSTRACT The finding of *Castnia invaria penelope* Schaufuss, 1870 in Ecuador (Rio Napo) is highlighted, thus extending the body of knowledge on the distribution of the ssp. Additional information on the genus and the congeneric species is also provided.

KEY WORDS Lepidoptera, Castniidae, *Castnia*.

Received 18.09.2011; accepted 24.09.2011; printed 30.09.2011

INTRODUCTION

The Castnids are nocturnal lepidoptera with diurnal (or crepuscular) habits. They are distributed mainly in the Neotropical region. Data concerning their distribution are fragmentary at best, and they are under-represented in institutional and private collections (González, 2004; Lamas, 1995; Vinciguerra & Racheli, 2006; Vinciguerra, 2011).

Several recent studies have extended the taxonomic body of knowledge on the family with the description of a new taxon (*Athis pirrelloi* Vinciguerra, 2011), the male of this interesting species was located twelve years after the capture of the holotype and it is also currently being described.

Three species have shown a more extensive geographical distribution than previously thought *Divana diva hoppi* (Hering, 1923), previously known to exist only in Colombia and now discovered also in Ecuador (Esmeraldas) (Vinciguerra, 2010); *Athis palatinus staudingeri* (Druce, 1896) described in Panama and captured in Costa Rica (Corcovado) (Vinciguerra & González, 2011) and, lastly, *Amauta hodeei kruegeri* (Niepelt, 1927) also considered endemic to Colombia and now located in Ecuador (personal data).

Castnia invaria Walker, 1854 is a widely studied species mainly because of its pest status on pineapple (*Ananas* spp., Bromeliaceae) plantations. This is a widely distributed species in South America and four sub-specific entities are recognized: *C. invaria invaria* Walker, 1854, *C. i. penelope* Schaufuss, 1870, *C. i. trinitatis* Lathy, 1925, *C. i. volitans* Lamas, 1995 (Lamas, 1995).

Castnia invaria penelope Schaufuss, 1870

The distribution of *Castnia invaria penelope* (Figs. 1-2) includes Argentina, Bolivia, Brazil and Paraguay. The taxonomic rank of the aforementioned subspecies requires further research because their status could be considered unclear due to a significant polymorphism. As all the ssp. known, the larvae feed on several Bromeliaceae, including pineapples (*Ananas* spp., Bromeliaceae). The imago has diurnal habits and the adults of *Castnia invaria penelope* have been observed flying (Paraguay) between 11 am and noon (Ríos & González, 2011).

We point out the presence of this species also in Ecuador (Rio Napo) on the basis of two specimens, collected in this region in 1974.

ACKNOWLEDGEMENTS

I would like to extend a special thanks to J. M. González (Texas A & M University) for comments given during the drafting stage of this short note.

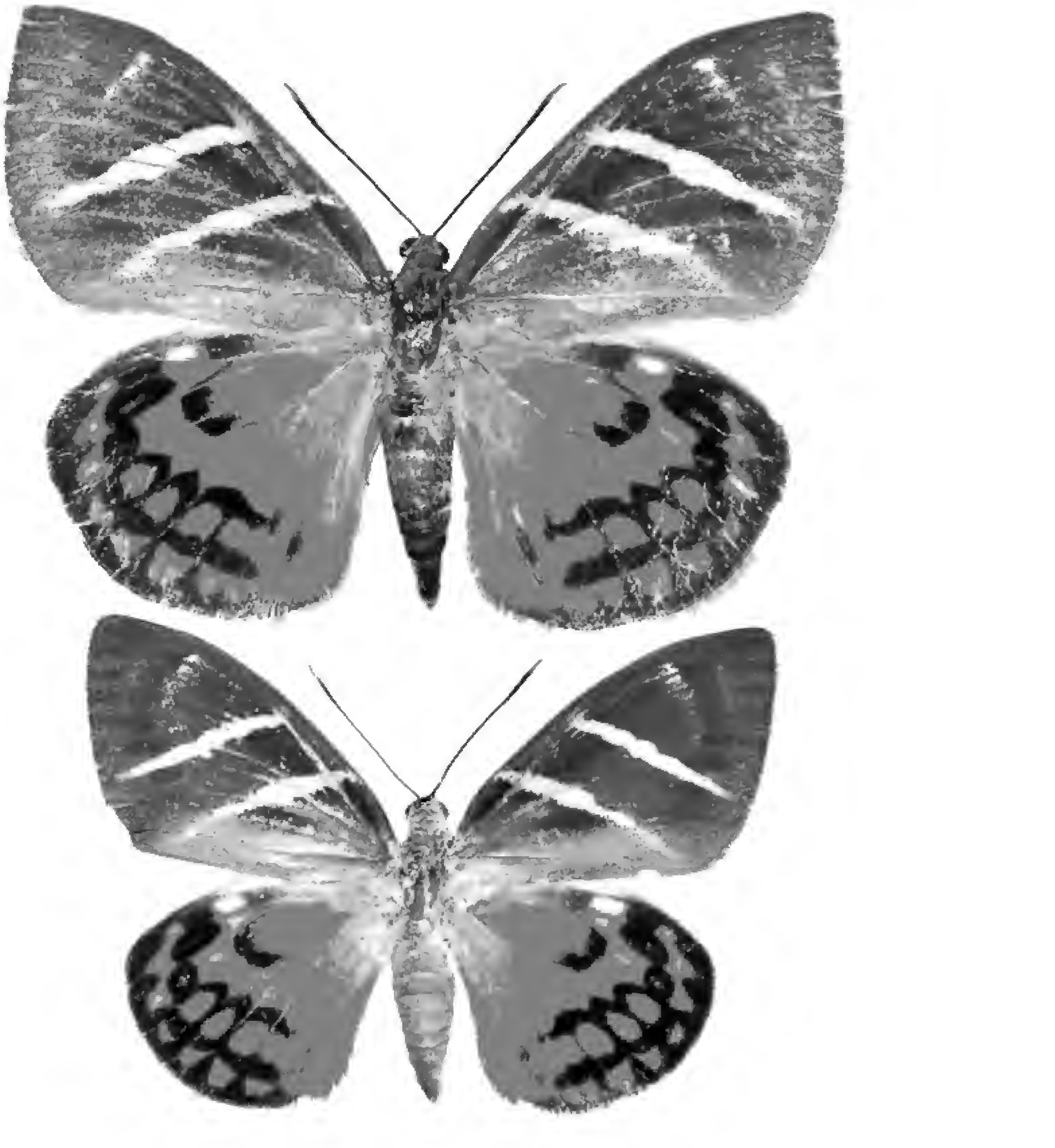


Fig. 1

Fig. 2

Figure 1. *Castnia invaria penelope* female, Ecuador, Rio Napo, 04.1974, width 80 mm.
Figure 2. *Castnia invaria penelope* male, Ecuador, Rio Napo, 04.1974, width 120 mm.

REFERENCES

González J.M., 2004. Castniinae (Lepidoptera: Castniidae) from Venezuela. VI. The genus *Athis*. Diagnosis and comments. Caribbean Journal of Science, 40: 408-413.

Lamas G., 1995. A critical review of J.Y. Miller's Checklist of the Neotropical Castniidae (Lepidoptera).Revista Peruana de Entomología, 37: 73-87.

Ríos S. & González J.M., 2011. Synopsis of the Castniidae (Lepidoptera) of Paraguay. Zootaxa (in press).

Vinciguerra R. & González J.M., 2011. Observations on distribution of *Athis palatinus staudingeri* (Druce, 1896) (Lepidoptera: Castniidae). Shilap Revista de Lepidopterología, 39: 155-159.

Vinciguerra R. & Racheli L., 2006. Note sulla distribuzione di alcuni Castnidi in Perù (Lepidoptera, Castniidae), Berichte des Kreises Nürnberger Entomologen V, 22: 27-39.

Vinciguerra R., 2010. Osservazioni sulla distribuzione di *Divana diva hoppi* (Hering, 1923), (Lepidoptera: Castniidae). Shilap Revista de Lepidopterología, 38: 379-383.

Vinciguerra R., 2011. Observations on the genus *Athis* Hübner, [1819] and description of a new species from Peru (Lepidoptera, Castniidae), Biodiversity Journal, 2: 97-102.

Biodiversity Journal, 2011, 2 (3): 151-152

A case of cannibalism in *Podarcis siculus campestris* De Betta, 1857 (Reptilia, Lacertidae)

Mauro Grano[1], Cristina Cattaneo[2] & Augusto Cattaneo[3]

[1] Via Valcenischia 24 – 00141 Roma, Italy; e-mail: elaphe58@yahoo.it - [2] Via Eleonora d'Arborea 12 – 00162 Roma, Italy; e-mail: cristina.cattaneo76@libero.it - [3] Via Cola di Rienzo 162 – 00192 Roma, Italy; e-mail: augustocattaneo@hotmail.com

ABSTRACT A case-report of cannibalistic behaviour in Italian wall lizard *Podarcis siculus campestris* De Betta, 1857 is described here along with the first photographic record

KEY WORDS Cannibalism, food spectrum, Italian wall lizard, *Podarcis siculus,* predation.

Received 25.09.2011; accepted 29.09.2011; printed 30.09.2011

INTRODUCTION

Podarcis siculus (Rafinesque-Schmaltz, 1810) s.l. is considered among the Mediterranean Lacertid lizards the species more adapted to inhabit a wide variety of habitats (Corti et al., 2011). The distribution area of *P. siculus* includes Italy, Corsica and the coastal regions of Croatia, Slovenia and Montenegro.

Naturalized populations have been found in Spain and Balearic Islands, Portugal, France, Turkey, Tunisia, Libia and United States. This highly polytypic species is represented in Lazio by ssp. *campestris* De Betta, 1857 (Capula & Ceccarelli, 2003).

In Italy, this lizard generally occurs in lowland and coastal areas, and also in anthropized areas such as urban park of large towns. It is found from sea level up to 1000 m and exceptionally up to 2200 m (Mount Etna, Sicily) (Turrisi & Vaccaro, 2001; Corti et al., 2011).

This species is often sympatric with *Podarcis muralis* (Laurenti, 1768), occupying sunny and more exposed microhabitats respect to this latter; also, no interspecific competition seems to occur between these species (Bologna et al., 2007). However, in some urban environments has been observed as the communities of *Podarcis muralis* e *P. siculus* are organized through specific ecological needs of each species rather than by species interactions (Capula et al., 1993).

Many studies have focused the feeding habits of *P. siculus*; the results showed that its preys spectrum can be interested by significant variations in relation to the different environmental contexts (Corti & Lo Cascio, 2002). It preys upon invertebrates and mainly insects, but occasionally vegetal matter and small vertebrates can complete the diet. Some studies have showed that most of Italian Lacertids eat really all the occurring invertebrates in their habitats in proportion on their availability (Scali et al., 2008).

Other studies (Lo Cascio & Capula, 2011) on *Podarcis raffonei* (Mertens, 1952) from Scoglio Faraglione (Aeolian Archipelago, NE Sicily) indicate that diet composition is not directly influenced by prey availability and temporal prey abundance and that this species can operate a hierarchical choice within the range of prey items constituting its prey spectrum.

Several cases of partial and/or true cannibalism have been reported in literature for this species (see e.g. Mertens, 1934; Kramer, 1946; Ouboter, 1981; Burke & Mercurio, 2002).

RESULT AND CONCLUSIONS

On 17th July 2011, at 10.46 a.m. on Tolfa's Mountains, Lazio (Italy), two of the Authors have surprised and photographed an adult male of Italian wall lizard during predation against a young conspecific. After attacking the small lizard on hind legs, limiting its mobility and preventing its escape, the predator carried away the prey in order to consume it hidden in a near bush (Fig. 1).

Recently, Cattaneo (2005) stated adult *Podarcis siculus* feed on the eggs and young of the same species and also the congener *Podarcis muralis nigriventris* Bonaparte, 1836; Capula & Aloise (2011) reported two unusual cases of predation, respectively, of a young conspecific and of a small-sized gecko *Hemidactylus turcicus* (Linnaeus, 1758); in the same paper is also given the photo of a *P. siculus* retaining in the mouth a dead specimen of *Suncus etruscus* (Savi, 1822) (Mammalia, Soricidae).

The observation contained in this work is a further contribution to the knowledge of cannibalism in *Podarcis siculus* and allows to confirm both the reports by Cattaneo (2005) and also by Capula & Aloise (2011).

Figure 1. Specimen of *Podarcis siculus campestris* (adult male) to prey a young of the same species (Tolfa's Mountains, Lazio, Italy, July 2011).

REFERENCES

Bologna M.A., Salvi D. & Pitzalis M., 2007. Atlante degli Anfibi e dei Rettili della Provincia di Roma. Provincia di Roma, Gangemi Editore, Roma, 192 pp.

Burke R.L. & Mercurio R.J., 2002. Food habits of a New York population of Italian Wall Lizard, *Podarcis sicula* (Reptilia, Lacertidae). American Midland Naturalist, 147: 368-375.

Capula M. & Aloise G., 2011. Extreme feeding behaviors in the Italian wall lizard, *Podarcis siculus*. Acta Herpetologica, Firenze University Press, 6: 11-14.

Capula M. & Ceccarelli A., 2003. Distribution of genetic variation and taxonomy of insular and mainland populations of the Italian wall lizard, *Podarcis sicula*. Amphibia-Reptilia, 24: 483-495.

Capula M., Luiselli L. & Rugiero L., 1993. Comparative ecology in sympatric *Podarcis muralis* and *P. sicula* (Reptilia: Lacertidae) from the historical centre of Rome: what about competition and niche segregation in an urban habitat? Bollettino di Zoologia, 60: 287-291.

Cattaneo A., 2005. L'Erpetofauna della Tenuta Presidenziale di Castelporziano (Roma). Atti del Museo di Storia Naturale della Maremma, 21: 49-77.

Corti C. & Lo Cascio P., 2002. The Lizards of Italy and Adjacent Areas. Chimaira Verlag, Frankfurt am Main, 165 pp.

Corti C., Biaggini M. & Capula M., 2011. *Podarcis siculus* (Rafinesque-Schmaltz, 1810). In: Capula M., Luiselli L., Razzetti E., Sindaco R. (eds.), Fauna d'Italia: Reptilia, Vol. XLV. Edizioni Calderini de Il Sole 24 ORE, Editoria Specializzata S.r.l., Bologna: 407-417.

Lo Cascio P. & M. Capula, 2011. Does diet in lacertid lizards reflect prey availability? Evidence for selective predation in the Aeolian wall lizard, *Podarcis raffonei* (Mertens, 1952) (Reptilia, Lacertidae). Biodiversity Journal, 2011, 2: 89-96.

Kramer G., 1946. Veränderungen von Nachkommenziffer und achlommengrössen sowie der Alters-verteilung con Inseleidechsen. Zeitschrift für Naturforschung, 1: 700-710.

Mertens R.,1934. Die Inselreptilien, ihre Ausbreitung, Variation und Artbildung. Zoologica, 32: 1-209.

Ouboter P.E., 1980. The ecology of the island lizard *Podarcis sicula salfii*: correlation of microdistribution with vegetation coverage, thermal environment and food size. Amphibia-Reptilia, 2: 243-257.

Scali S., Spadola F., Di Toro F., Gentili A., Mangiacotti M., Tettamanti S. & Cavigioli L., 2008. Plasticità trofica di due Lacertidi italiani: casi di predazione anomala in *Lacerta bilineata* e *Podarcis muralis*. In: Corti C. (ed.), Herpetologia Sardiniae. Societas Herpetologica Italica, Edizioni Belvedere, Latina: 435-438.

Turrisi G. F. & Vaccaro A., 2001. Distribuzione altitudinale di Anfibi e Rettili sul Monte Etna (Sicilia orientale). Atti 3° Congresso Nazionale di Erpetologia. Pianura, 13: 335-338.

Biodiversity Journal, 2011, 2 (3): 153-159

A new subspecies of *Perotis lugubris* Fabricius, 1777 from Southern Italy (Coleoptera, Buprestidae).

Francesco Izzillo[1] & Ignazio Sparacio[2]

[1]Via O. Buccini, 10 – 81030 Orta di Atella, Caserta, (I); e-mail: franco.izzillo@gmail.com. [2]Via E. Notarbartolo, 54 int. 13 – 90145 Palermo, (I); e-mail: isparacio@inwind.it.

ABSTRACT A new subspecies of Coleoptera Buprestidae, *Perotis lugubris meridionalis* n. ssp. from Southern Italy, is described, illustrated and compared with related taxa.

KEY WORDS Coleoptera, Buprestidae, *Perotis lugubris meridionalis* n. ssp., Southern Italy.

Received 14.06.2011; accepted 20.08.2011; printed 30.09.2011

INTRODUCTION

Perotis lugubris Fabricius, 1777 s.l. is a Coleoptera Buprestidae of the subfamily Chrysochroinae Laporte, 1835 tribe Dicercini Gistel, 1848 widely distributed in Central Asia (Turan)-SE Europe (Kubán, 2006).

The nominal subspecies (locus typicus: Austria) is widespread in many Central and Eastern European states, Balkan Peninsula and Turkey; the ssp. *mutabilis* Abeille, 1896 is known for Iran, Iraq, Lebanon, Syria and Turkey; the ssp. *longicollis* Kraatz, 1880 from Azerbaijan, Armenia, southern Russia, Iran, Iraq, Turkmenistan and the ssp. *transcaspica* Semenov, 1891 is reported for Iran and Turkmenistan (cfr. Kubán, 2006).

In Italy there is the nominal subspecies in Friuli Venezia Giulia, Marches, Liguria, Tuscany, Latium, Campania and Apulia (Lecce) (Luigioni, 1929, Porta, 1929; Curletti, 1985; Platia & Gobbi, 1995). An old report from Sardinia (Porta, 1929) was never confirmed (Curletti, 1985; Gobbi & Platia, 1995); a citation for Sicily was made by Romano (1849), although remained unknown or at least never reported by other authors.

Bertolini (1899) and Reitter (1906) signalized in southern Italy *Perotis xerses* v. *viriditarsis* Schaufuss, 1879; Luigioni (1929) and Porta (1929) reported this quote but Obenberger (1926) considered this variety a synonymous of *P. xerses* Marseul, 1865 from Asia Minor and excluded it from italian Coleoptera; moreover, Obenberger himself (1924-1932) acknowledged this quote was wrong.

The examination of material collected from Southern Italy, Basilicata in particular, has allowed us to highlight some morphological peculiarities in these populations that can be described as a new subspecies.

ACRONYMS. The materials used for this study are deposited in the following Museums and private collections: F. Angelini, Francavilla Fontana (Brindisi), Italy (CA); M. Bollino, Lecce, Italy (CB); P. Crovato, Naples, Italy (CC); D. Gianasso, Castelnuovo Don Bosco (Asti), Italy (CG); M. Gigli, Rome, Italy (CMG); Istituto Nazionale di Entomologia, Rome, Italy (INER); F. Izzillo, Orta di Atella (Caserta), Italy (CI); A. Liberto, Rome, Italy (CL); G. Magnani, Cesena, Italy (CM); C.O. Manci, Iasi (Romania) (CCM); E. Migliaccio, Rome, Italy (CEM); Museo

Civico di Storia Naturale di Genova, Italy (MSNG); Museo Civico di Zoologia, Rome, Italy (MCZR); D. Sechi, Quartu Sant'Elena (Cagliari), Italy (CS); I. Sparacio, Palermo, Italy (CIS).

Where not specified, the collector is the same owner of the collection.

Perotis lugubris meridionalis n. ssp.

EXAMINED MATERIAL. Holotypus male: Italy, Basilicata (Matera): Policoro, 26.VI.1989, legit F. Izzillo (CI). Allotypus female: same data as holotypus (CIS); Paratypi: Italy, Basilicata (Matera): Policoro, 27.VI.1991, legit F. Izzillo, 1 ex (CIS); idem, 8.VII.1989, legit F. Izzillo, 2 exx (CIS); idem, 8.VII.1989, legit P. Crovato, 2 exx (CIS); idem, 18.VII.1990, legit F. Izzillo, 1 ex (CIS); idem, 5.VI.1989, legit N. Liantonio, 1 ex (CIS); idem, 10.VII.1989, legit P. Crovato, 1 ex (CIS); idem, 5.VII.1989, 1 ex (CI); idem, 6.VII.1989, 2 exx (MSNG); idem, 6.VII.1989, 1 ex (CI); idem, 6.VII.1989, legit N. Liantonio, 1 ex (CI); idem, 8.VII.1989, legit N. Liantonio, 1 ex (CI); idem, 10.VII.1989, 1 ex (CI); idem, 23.VI.1990, 2 exx (CI); idem, 10.VII.1990, legit I. Izzillo, 2 exx (CI); idem, 11.VII.1990, 1 ex (CI); idem, 21.VII.1990, legit F. Angelini, 1 ex (CI); idem, 23.VII.1991, 1 ex (CI); idem, 25.VII.1991, 3 exx (CI); idem, 25.VII.1991, legit N. Liantonio, 1 ex (CI); idem, 27.VII.1991, 1 ex (CI); idem, 27.VII.1991, legit N. Liantonio, 1 ex (CI); idem, 4.VI.1992, 2 exx (CI); idem, 6.VI.1993, 2 exx (CI); idem, 26.VI.1994, 1 ex (CI); idem, 3.VII.1994, 2 exx (CI); idem, 10.VII.1994, 1 ex (CI); idem, 23.VII.1994, 2 exx (CI); idem, 4.VI.1995, 2 exx (CI); idem, 16.VI.1996, 1 ex (CI); idem, 13.VII.1996, 1 ex (CI); idem, 26.IV.1999, 1 ex (CI); idem, 10.VII.1989, legit F. Izzillo, 1 ex (CA); idem, 28.VII.1990, 1ex (CA); idem, 24.VII.1994, 1 ex (CA); idem, 26.VI.1989, legit F. Izzillo, 1 ex (CG); idem, 23.VII.1991, legit F. Izzillo, 1 ex (CM); idem, 25.VII.1991, legit F. Izzillo, 3 exx (CM); idem, 27.VII.1991, legit F. Izzillo, 1 ex (CM); idem, 4-5.VII.1992, 2 exx (CM); idem, 23.VII.1994, legit F. Izzillo, 1 ex (CS); idem, 10.VII.1989, legit F. Izzillo, 1 ex (CL); idem, 3.VII.1994, legit F. Izzillo, 1 ex (CL); idem, 18-20.VI.1996, legit A. Liberto, 2 exx (CL); idem, 6.VII.1989, legit F. Izzillo, 1 ex (CC); idem, 8.VII.1989, 1 ex (CC); idem, 23.VI.1990, legit F. Izzillo, 1 ex (CC); idem, 23.VI.1990, 1 ex (CC); idem, 6.VI.1993, legit F. Izzillo, 1 ex (CC); idem, 5.VII.1994, 2 exx (CC); idem, 23.VII.1994, legit F. Izzillo, 1 ex (CC).

Apulia (Lecce): Ugento, Lido Marini (Macchia Rottacapozza), 8-10.V.1993, legit M. Portalatina, 2 exx (CB).

Holotypus, allotypus and paratypi are deposited in the cited collections.

DESCRIPTION OF HOLOTYPUS MALE. Length 19 mm; width (near elytral base) 7 mm; body ovoid, large, convex; bronze-green. Frons, antennae, legs and ventral surface with short, sparse and white pubescence.

Epistome concave. Frons large, slightly convex, with big and irregular puncture; intervals are microreticulated and irregularly raised. Eyes big, protruding, converging dorsally.

Antennal cavities large, oblique and deep. Antennae short, serrate from fifth segment; first antennomere short and rounded, a little dilated anteriorly, second one little and short, about half as long as the first; third antennomere is about twice as long as the second; fourth little longer than the third, slightly denticulate anteriorly; fifth denticulate; segments 6-10 widely sub-squared with obtuse outer angles; terminal antennomere rounded, little elongated.

Pronotum convex, trasverse, 1.7 times as wide as long, lateral margins converging anteriorly, maximum pronotal width at basal third, posterior angles straight and protruding, anterior angles slightly protruding; anterior pronotal margin slightly bisinuate, posterior margin bisinuate and distinctly lobate in the middle. Pronotal sculpture consisting of rounded, deep and little dense punctures that are gathered and irregular at the sides of pronotum; interspace between punctures is microreticulated.

Scutellum small and transverse. Elytra 1.8 times as long as wide, slightly wider than pronotum at humeral part, wide and arched at basal third, narrowed at elytral apices; humeral swellings small but well-developed; apex of elytra obliquely truncate, not tighten.

Elytral sculpture consisting of irregular striae of deep punctures, interspace between punctures is microreticulated; intervals represented by some remarks smooth, irregular, fragmented and absent on the sides of the elytra and at the apex.

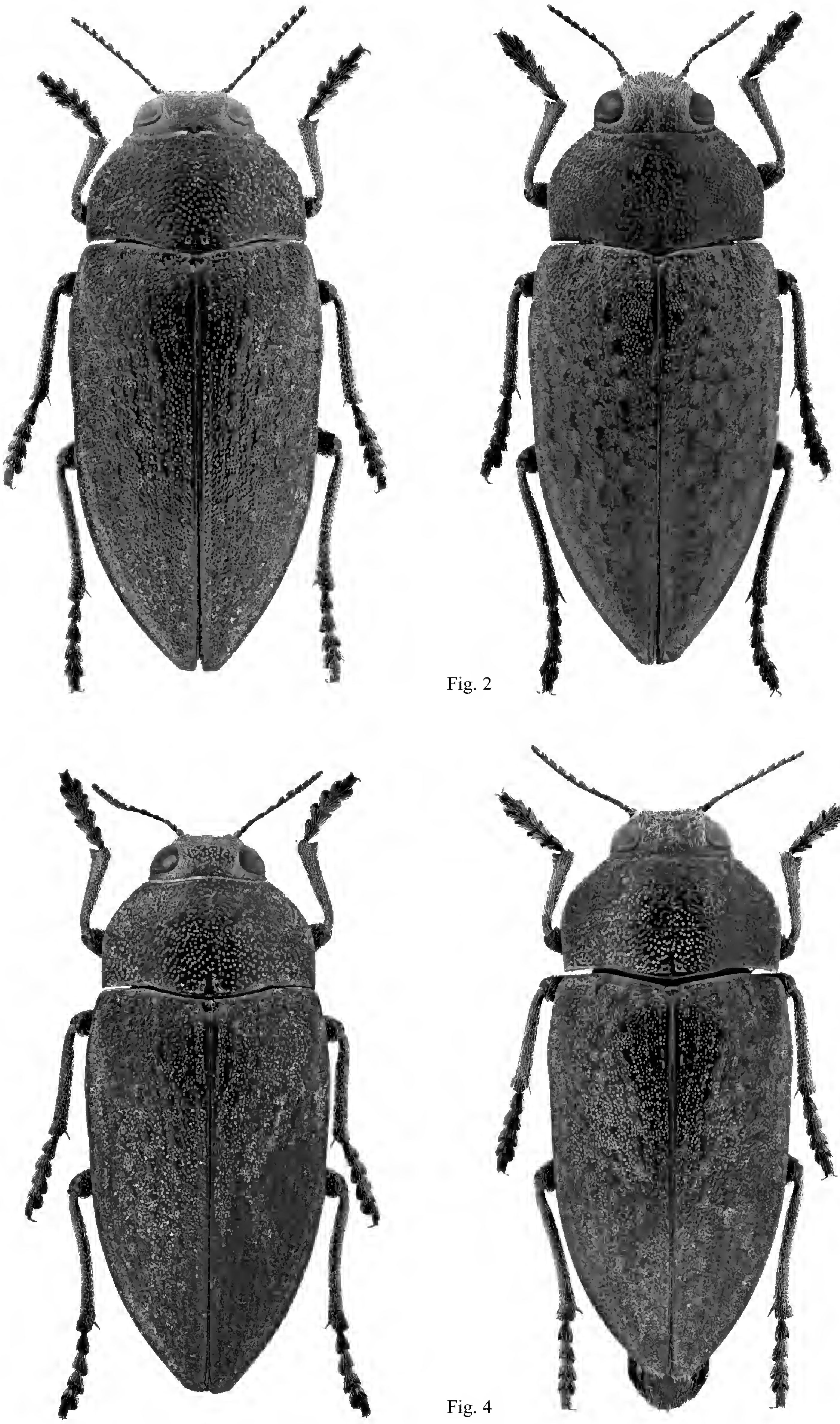


Fig. 1 Fig. 2 Fig. 3 Fig. 4

Figure 1. *P. lugubris meridionalis* n. ssp. from Italy, Matera, Policoro (length 20 mm).
Figure 2. *P. lugubris lugubris* from Slovakia, Hegy Farok (length 20 mm).
Figure 3. *P. lugubris lugubris* from Italy, Rome, Castelfusano (length 21 mm).
Figure 4. *P. lugubris lugubris* from Greece, Attica, Legrena (length 22 mm;).

Large and distinct elytral epipleura, reaching apex of elytra.

Legs relatively long, protibiae with a tooth anteriorly, metatibiae curved on the outside; 1-4 segments of tarsi dilated, the first one narrower than the other three, fifth flat and rectangular.

Prosternum with big and dense punctuation, prosternal process with a median and smooth prominence and with big and sparse punctures; the sides of prosternal process are dilated and angled, apex truncate and rounded.

Metasternum with punctures and a deep median furrow; between posterior coxae there are two prominences close and slightly divergent posteriorly, extending up the 1st sternite without reaching the back edge.

Sternites microreticulated with big and irregular punctures, sometimes thickened; anal sternite truncated at apex.

Aegeagus little enlarged at apical third with parameres narrow and elongated anteriorly; median lobe pointed apically.

VARIABILITY. The length of the specimens examined varied from 14 to 25 mm; the width from 5.5 to 11 mm. The dorsal surface is always green, sometimes very notable. Anal sternite of the males sometimes more or less concave. The females have the same characteristics of the males but are usually larger and more convex dorsally.

ETIMOLOGY. From southern Italy, particularly Basilicata and Apulia (Salento) where this new taxon was collected.

BIOLOGY AND DISTRIBUTION. *P. lugubris* s.l. is a quite rare species in Italy. Its findings are sporadic, generally discontinuous and occasional. This species seems to prefer the Mediterranean maquis as elective habitat, although occurring, at very low frequencies and at low altitudes, in the most exposed areas of mesophilic forests and cultivated areas, given certain conditions. In particular, it is present in cultivated fields where intensive farming techniques are not employed, where agricultural cultivation is followed by relatively long periods of stasis, and that are interspersed with areas of natural vegetation (Authors'personal observations).

The forest Pantano-Sottano di Policoro, the main site of collection of the new subspecies, in the last two decades has undergone a profound transformation due to altered environmental conditions occurred as a result of the barrage with dams upstream of some rivers (particularly of Sinni river); these works have gradually led primarily to a drastic reduction of water intake and, subsequently, to depletion of groundwater beneath the forest. This situation has greatly affected vegetation of the area and actually has impoverished the rich population of arthropods occurring therein.

Over the years, starting from the peripheral areas of the forest, there has been a gradual regression of hygrophilous plants such as ash, poplar (white and black), willow, alder, as well as the elm trees [these latter also because of Dutch elm disease (DED)]. At the same time, several species peculiar of the Mediterranean maquis or, however, of xeric areas such as mastic, myrtle, *Phyllirea* and *Crataegus* gradually moved forward and, as a further sign of a progressive drying up of the area, it is now possible to come across a few plants of maritime pine and *Quercus* sp (= xerophytes), recently settled. In such an environment and in the most exposed areas at the edge of the forest we found, quite frequent, *Perotis* specimens.

In line with what already reported in other countries (Lebanon, Greece and Crete), we observed specimens of the subspecies *meridionalis* often in flight from bush to bush or, more or less hidden, clinging to small diameter branches, behaving similarly as congeneric beetles. At Policoro, in particular, *P. lugubris meridionalis* seem to be present at all the shrubs of the Mediterranean maquis, without any particular preference (but we never observed it on Juniper). We have seen a few couplings on *Quercus* sp. and *Crataegus* sp.; during mating animals stood motionless on twigs, half-concealed, with no detectable activities, just like other taxa of the family.

Only once we observed it gnawing the apical part of a small branch of a young oak tree. If it feels in danger, *P. lugubris meridionalis* tends to turn around the branch or drop down, and, more rarely, it can fly away quickly. As all taxa belonging to the family Buprestidae, it is a phytophagous species the larva of which is

polyphagous and radicicolous on trees and shrubs; Curletti et al. (2003) reported it as host of *Arbutus unedo*, *Malus* sp. and *Pistacia lentiscus*, but, within broad-leaved trees, the taxon certainly feeds on a broader spectrum of plants than established so far.

At present, *P. lugubris meridionalis* is known for some coastal places of Basilicata and Apulia (Salento).

COMPARATIVE NOTES. *P. lugubris meridionalis* n. ssp. appears to be well differentiated from neighboring populations attributable to the nominal subspecies, by many characters as follows: the body is narrower and greenish in colour (Fig. 1), pronotum with lateral margins narrowed anteriorly and with the punctures smaller and little dense, the shape of the antennae (Fig. 5) with 4th and 5th articles less denticulate, a minor extension of residual elytral intervals, the shape of the prosternal process (Fig. 9), the punctuation of abdominal sternites and aedeagus (Fig.13). In *P. lugubris lugubris*, the body is wider, more convex, bronze, rarely with green tinge (Fig. 2), pronotum is wider and convex with maximum width in the middle and punctures bigger and dense; antennae (Fig. 6) with 4th and 5th articles more denticulate, 7th-10th larger, straight or slightly rounded at corners, 11th more elongated; elytra wider and curved at the sides with the greater extent of residual elytral intervals; prosternal process wider at the base and rounded at the sides (Fig. 10), sternites with punctuation bigger, dense, irregular and confluent; aedeagus (Fig. 14) more dilated anteriorly with curved sides.

These morphological characters have been observed in the populations from Central and Eastern Europe (locus typycus: Austria) and, with some minor variations, even in the Italian populations of Latium and N-Apulia (Figs. 3, 7, 11, 15). For Campania we observed only one small male specimen that seems similar to the nominal subspecies.

The populations from Greece, however, show major differences from the nominal subspecies (Figs. 4, 8, 12, 16), especially in shape of prosternal process and aedeagus. The ssp. *prolongata* described by Obenberger (1918) from Greece, without precise location, is considered just a form of no taxonomic validity by Mühle et al. (2000).

EXAMINED MATERIAL. *Perotis lugubris lugubris* Fabricius, 1777.

SLOVAKIA. Hegy Farok, 27.VI.1972, legit O. Marek, 2 exx (CIS); Plast'ovce 12-15.V.1999, legit V. Krivan, 3 exx (CS); Kamenica n. Hronom, legit L. Klíma, 5.VI.1983, 3 exx (CS); Kamenica n. Hronom, 30.IV.1994, legit S. Baron, 1 ex (CS); Stùrovo, 20.VI.1993, legit S. Baron, 1 ex (CS); Slovacchia, 30.V.1988, legit V. Mikes, 1 ex (CS); Stùrovo, 9.V.1977, legit J. Hala, 1 ex (CM); Stùrovo, 15.V.1976, legit J. Hala, 1 ex (CM).

ROMANIA. Oltenia-Mehedinți Gura Văii (near) clearing, 44.675421/22.539392, 120 m, 16.VI.2003, 1 ex (CCM); Dobrogea-Tulcea, Babadag (near), Babadag forest, 44.817756/28.750953, 100 m, 17.VII.2008, 1 ex (CCM).

BULGARIA. Volcanic Hill "Kozhuh" (Petrich), 11.IV.2004, 1 ex (CEM).

GREECE. Attica, dintorni Legrena, 25/30. IV.1991, legit A. Liberto, 3 exx (CIS); idem, 1 ex (CG); Legrena littoral, 26.IV.1991, legit A. Liberto, 5 exx (CIS); Ahaia (Peloponnesos), Halandritsa, 3.VII.1993, 1 ex (CEM); Etolia, Lessini, 1-3.VII.1993, 2 exx (CEM); Attica, dintorni Lavrio, 10.V.1991, legit A. Liberto, 1 ex (CG); Attica, dintorni Kalivia, 22.IV.1988, legit A. Liberto, 1 ex (CG); Trikala, Meteora, 18.V.1977, 1 ex (CG); Ahaia, Kalavrita, 1-3.VII.1996, 2 exx (CM); Thessalia, Stomion, VI. 1984, legit J. & M. Slàma, 1 ex (CM); Argolida, Epidauros, 2.V.1999, 2 exx (CA); Ahaia, Kalavrita, 17-21.VI.1998, 2 exx (CA); Limnos Island, Thanos Beach, 28-29.VII.2006, 1 ex (CS); Attica, Legrena, 16.V. 1995, 4 exx (CI); idem, 17.V.1995, 3 exx (CI); idem, 18.V.1995, 14 exx (CI); Attica, Capo Sounio, 16.V.1995, 13 exx (CI); Attica, Mandra, 19.V.1995, 1 ex (CI); Ahaia, Kalavrita, 3.VII.1996, 3 exx (CI); idem, 18.VI.1998, 3 exx (CI); idem, 24.VI.1998, 1 ex (CI); Korinthia, Killini Oros, 23.V.2004, 1 ex (CI); Argolida, Asini, 24.V.2004, 1 ex (CI).

TURKEY. Akhisar, 28.V.1974 (CEM); idem, 18.VI.1974 (CEM).

ITALY. Marches. Pesaro, VIII.1951, legit Berardi, 1 ex (INER).

Tuscany. Grosseto, Follonica dintorni, VI.1962, legit Bianciardi, 2 exx, coll. G. Gobbi (MCZR); Livorno, VI.1938, 1 ex coll. Cerruti (INER).

Latium. Roma, Castelfusano, 7.VII.1955, legit G. Montelli, 2 exx (CEM); idem, 1 ex,

Fig. 5 Fig. 6 Fig. 7 Fig. 8

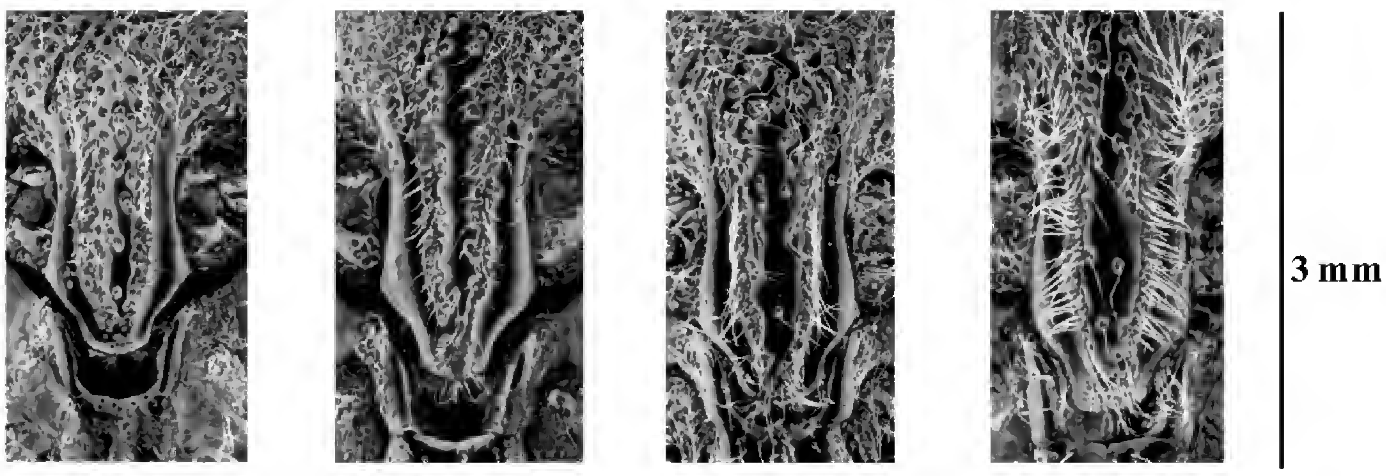


Fig. 9 Fig. 10 Fig. 11 Fig. 12

Fig. 13 Fig. 14 Fig. 15 Fig. 16

Figures 5-8. Antennae of *P. lugubris meridionalis* n. ssp. from Italy, Matera, Policoro (5), *P. lugubris lugubris* from Slovakia, Hegy Farok (6), *P. lugubris lugubris* from Italy, Rome, Castelfusano (7), *P. lugubris lugubris* from Greece, Attica, Legrena (8).
Figures 9-12. Prosternal process of *P. lugubris meridionalis* n. ssp. from Italy, Matera, Policoro (9), *P. lugubris lugubris* from Slovakia, Hegy Farok (10), *P. lugubris lugubris* from Italy, Rome, Castelfusano (11), *P. lugubris lugubris* from Greece, Attica, Legrena (12).
Figures 13-16. Aedeagus of *P. lugubris meridionalis* n. ssp. from Italy, Matera, Policoro (13), *P. lugubris lugubris* from Slovakia, Hegy Farok (14), *P. lugubris lugubris* from Italy, Rome, Castelfusano (15), *P. lugubris lugubris* from Greece, Attica, Legrena (16).

Perotis lugubris Fabr., det. F. Tassi, 1961; idem, VII.1955, legit C. Saraceni, ex coll. S. Cafaro, 1 ex (CEM); idem, VII.1955, 1 ex (CEM); idem, VI.1956, legit S. Cafaro (CEM); Castelfusano, VII.1962, legit Ramaccini, 1 ex, coll. G. Gobbi (MCZR); idem, VII.1963, 1 ex, coll. G. Gobbi (MCZR); idem, 22.VI.1969, 1 ex, coll. G. Gobbi (MCZR); idem, VI.1955, legit G. Montelli, 1 ex, coll. G. Gobbi (MCZR); idem, VII.1965, legit D. Ruggiu, 1 ex, coll. G. Gobbi (MCZR); idem, 6.VII.1954, legit E. De Maggi, 2 exx (MCZR); idem, 24.VII.1954, legit E. De Maggi, 1 ex (MCZR).

Roma, Maccarese, 4.VI.2009, 1 ex (CMG).

Porto Anzio, VII.1918, 1 ex, legit Straneo, *Perotis lugubris* F., det. Obenberger.

Campania. Napoli, Villa Comunale, VIII.1911, legit Anguis (MCZR).

Apulia. Apricena dintorni (Foggia), 1.VI.2001, legit W. Pagliacci, 5 exx (CM).

CONCLUSION

Although *Perotis lugubris* s.l. is a polytypic species with a certain degree of intraspecific variability, nevertheless *P. lugubris meridionalis* ssp. is clearly differentiated and morphologically distinguishable from all other known populations, particularly those geographically close. Future research should be aimed at a reassessment of all taxonomic populations of *Perotis lugubris* s.l. and at a better definition of the presence of *P. lugubris meridionalis* n. ssp. in Southern Italy.

ACKNOWLEDGEMENTS

We thank all the friends and colleagues who have provided data and/or material in their possession facilitating the preparation of this work, particularly: Ferdinando Angelini (Francavilla Fontana, Brindisi, Italy), Maurizio Bollino (Lecce, Italy), Paolo Crovato (Naples, Italy), Domenico Gianasso (Castelnuovo Don Bosco, Asti, Italy), Maurizio Gigli (Rome, Italy), Andrea Liberto (Rome, Italy), Gianluca Magnani (Cesena, Italy), Cosmin Ovidiu Manci (Iasi, Romania), Enrico Migliaccio (Rome, Italy), and Daniele Sechi (Quartu Sant'Elena, Cagliari, Italy).

A special thanks to Marcello Romano (Capaci, Palermo, Italy) for photographs and to Gianluca Magnani for helpful suggestions.

REFERENCES

Bertolini S., 1899. Catalogo dei Coleotteri d'Italia. Ed. Rivista Italiana di Scienze Naturali, Siena, 144 pp.

Curletti G., 1985. I Buprestidi d'Italia. Catalogo Tassonomico, Sinonimico, Biologico, Geonemico. Monografie di Natura Bresciana, 19, Ed. Vannini, Brescia, 318 pp.

Curletti G., Rastelli M., Rastelli S. & Tassi F., 2003. Coleotteri Buprestidi d' Italia. Piccole Faune. Museo Civico di Storia Naturale di Carmagnola (Torino) e Progetto Biodiversità Comitato Parchi - Centro Studi (Roma), CD-ROM.

Gobbi G. & Platia G., 1995. Coleoptera Polyphaga VII (Elateroidea, Buprestoidea). In: Minelli A., Ruffo S. & La Posta S. (eds), Checklist delle specie della fauna italiana, 52. Calderini, Bologna.

Luigioni P., 1929. Catalogo dei Coleotteri d'Italia. Memorie della pontificia Accademia Scienze Roma, 13: 1-1160.

Kubán V., 2006. Buprestidae: Chrysochroinae Dicercini, 346-350 pp. In: Löbl I. & Smetana A. (ed): Catalogue of Palaearctic Coleoptera, 3. Apollo Books, Stenstrup, 690 pp.

Mühle H., Brandl P. & Niehuis M., 2000. Catalogus Faunae Graeciae: Coleoptera, Buprestidae. Augsburg, Selbstverlag, 254 pp.

Obenberger J., 1918. Ein weiterer Beitrag zur Kenntnis der palaearktischen Buprestiden. Entomologische Blätter, 14: 19-25.

Obenberger J., 1924-1932. Buprestidae. In: Winkler A., 1924-1932. Catalogus Coleopterorum regionis palearcticae. Wien, 620-663.

Obenberger J., 1926. Buprestidae I. In: Junk W. & Schenkling S., Coleopterorum Catalogus, pars 84. W. Junk, Berlin, 212 pp.

Porta A., 1929. Fauna Coleopterorum italica. Vol.III, Diversicornia – Stabilimento Tipografico Piacentino, Piacenza, 466 pp.

Reitter E., 1906. Neue Coleopteren aus der palaearktischen fauna. Wiener Entomologische Zeitung, 25: 31-37.

Romano B., 1849. Coleotteri della Sicilia raccolti e posseduti da Baldassare Romano. Tipografia F. Lao, Palermo, 28 pp.